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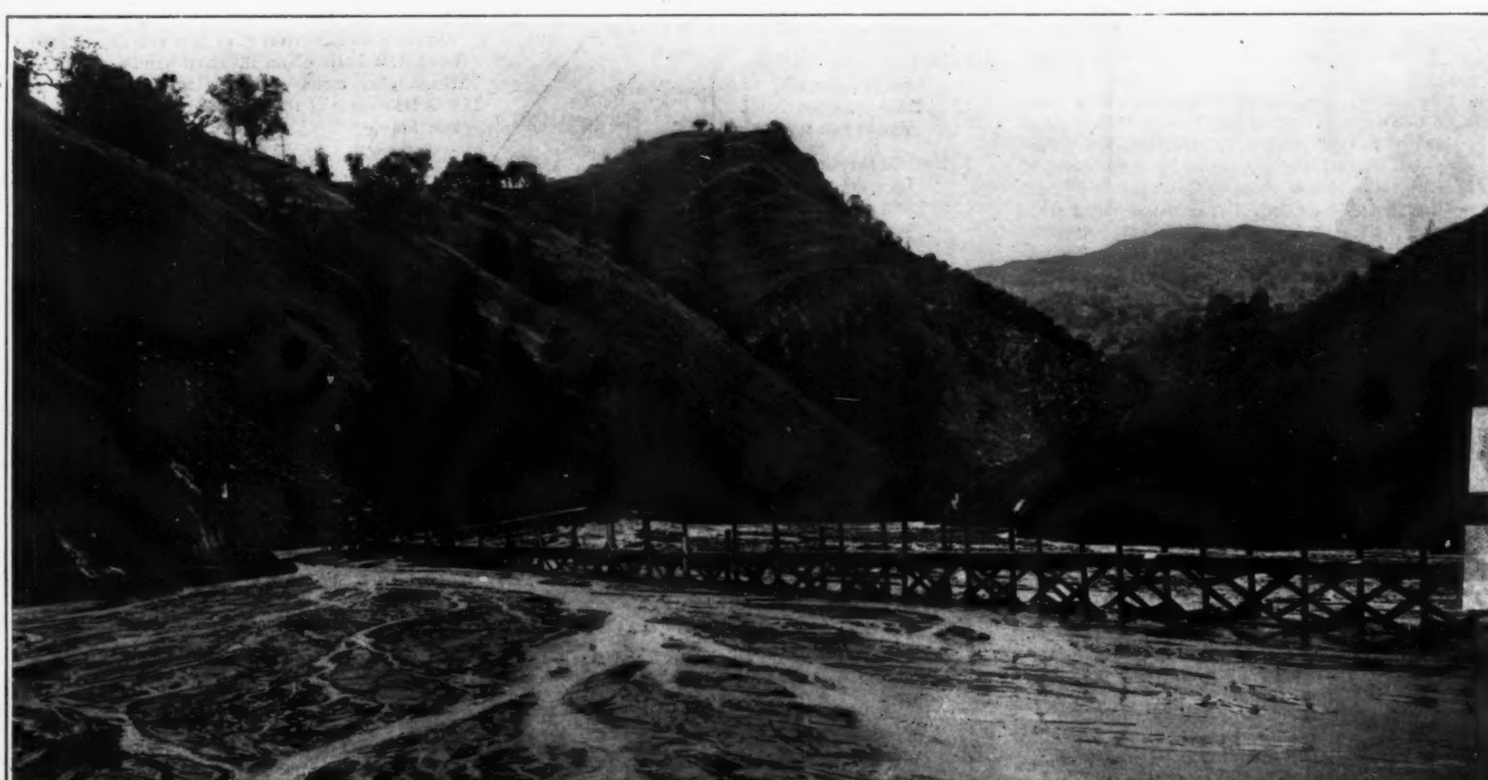
A great "monitor" hydraulic jet excavating material of which the dam is to be formed.



Material for forming the dam being delivered by pumps at the downstream toe.

BUILDING A BIG EARTH DAM.—[See page 5.]

A Psychological Analysis of Stuttering*

Indicating Faulty Visualization at Time of Speech

By Walter B. Swift, A.B., S.B., M.D.

The object of this paper is to carry the analysis of stutter phenomena deeper than before. In my last year's paper I showed that chronologically the diagnosis of dyslalia mounted step by step from a material external affair, up through the nerves until we came to the basal ganglia. I showed conclusively that it was an involvement that did not exist in any of these places. I further took steps to demonstrate and present evidence that indicated that dyslalia was in its essence some trouble with the personality. I mean by this, that trouble was located in the nervous system beyond the lower sensory areas of the sensorium; and also above the lower motor areas on the motor side. By the broad term "personality" I mean the total of the activities and interrelations of mental activities that occur above our lower sensory and motor areas. The paper of last year clearly located the trouble vaguely in this region of the personality.

Since that time I have been interested to ascertain just what the nature of this changed personality is. In order to do so, I have carried on an investigation that has reached interesting conclusions. To me it is new truth. It may not be all the truth, but as far as it goes, and as for what it is, it surely is truth and a new finding! This research is an effort to show not only where it is but *what it is*.

The method was as follows: For the purpose of finding out some of the activities going on in the area of collaboration during speech, I asked my stuttering patients two simple questions. I have thus found that their methods of collaboration complied to a certain mental type.

Then I carried this same method into the study of normal individuals in the collaboration of their ideas, just before and during speech in order to establish a norm; and to see whether or not it differed from my preliminary test of stuttering cases just mentioned. It did, and therefore I formulated a series of questions in order to pin the type of collaboration down to certain fields of mental action. To make this clear, let me present an outline of these different steps in tabular form.

1. Orientation tests on stutterers.
2. Orientation tests on normal individuals.
3. The research, its objects and methods.
4. Final detailed results.

Let us now pass to a minuter description of each of these procedures and a tabulation of the data that resulted.

1. PSYCHOLOGICAL ORIENTATION TESTS ON STUTTERERS.

By orientation test I mean simply a vague try-out to see just where the problem lies; an initial step to see what further steps are necessary; or, in other words, enough of an investigation to know where to look next.

The orientation tests consisted in requesting a series of twenty stuttering cases to answer two questions. Following their answers an immediate inspection was made of the content of their consciousness before, during, and after speech. These two question were as follows:

1. Where do you live?
2. Say after me "The dog ran across the street."

After these questions I asked the patients to state whether there was any picture in the content of consciousness and how long it lasted; also whether that was detailed, intense or weak. I noted the presence of stuttering in relation to the presence or absence of this mental imagery; and also made a note of any other unusual data that happened. The results of the tests indicated above can be summarized as follows:

Of the twenty stutterers examined, ten made no visualization of their homes, some even after a residence of years; one of these twenty visualized home very faintly; two others visualized home clearly but the picture vanished on speaking; seven others visualized home clearly but these had been under treatment.

On repeating the dog statement, ten stutterers made no visualization whatever; one visualized faintly; four visualized well but the picture vanished on speaking; five others reported visualization, and four of these had been under treatment.

At first I did not know but what this was the norm of average visualization methods; so I tried this same series upon a number of normal individuals for comparison; by normal individuals, I mean, at this time, merely anyone who is free from stuttering, and chosen in a haphazard way from the hospital community; for example, one was our executive secretary, another a typewriter, another a telephone operator and so on.

2. PSYCHOLOGICAL ORIENTATION TESTS ON NORMAL INDIVIDUALS.

The results of these orientation tests upon normal individuals were as follows:

The normal individuals examined, almost without exception visualized clearly before and during speech. Sometimes this visualization was very marked in detail and resulted in emotional responses, such as pleasure, etc.

From the above two sets of figures were thus obtained a fair norm of visualization for ordinary individuals; and in comparison a marked variation from this in stutterers. This data therefore warranted the tentative conclusion that stutterers have a loss or diminished power of visualization. This assertion may seem a little more than is warranted by such meagre data and, perhaps, would be better revised pending further data into the following: As compared with the normal, stutterers show a weakness in visualization.

3. THE RESEARCH, ITS OBJECT AND METHODS.

These general orientation tests for a norm and its pathological variation were the basis upon which I proceeded on broader lines with a further and more exhaustive investigation with the following points in view:

To what extent is visualization weak?

Is it weaker in the worst cases?

Is it less and less weak as cases appear less severe?

Is it the same for past, present and future memories?

Is visualization equally at fault in all sensory areas of the cortex?

Do cases approach normal visualization processes in proportion as they progress in their cure?

And lastly, numerous other minor queries presented themselves.

All these questions were answered in the following research which, after thus much orientation, found a more complete and final form.

In order to answer these questions I formulated the following series of tests to the number of twenty-four in all, and asked them in series to nineteen stutterers, making almost four hundred tests:

1. Speech: Say
   Today is sunny.
   The dog ran across the street.
   Submarines will sink all the steamers.

2. Motor:
   Do you dance?
   Did you ever skate?
   Would you sew for a living?

3. General Sensory:
   How does a pinch feel?
   Did you ever get hurt?
   What would you like to do if it was very hot next summer?

4. Hearing: (Eyes closed)
   Do you hear anything?
   Did you ever hear a rooster crow?
   What sounds would you like to hear next summer?

5. Sight: (Eyes closed)
   What do you see now?
   What did you see yesterday?
   What would you like to see next summer?

6. Smell: (Eyes closed, pen to nose)
   Do you smell anything?
   What have you told by smell?
   What would you like to smell next summer?

7. Taste: (Eyes closed)
   Do you taste anything?
   What have you been able to tell by the taste?
   What would you like to taste next summer?

8. Muscle Sense: (Eyes closed)
   Put one arm up; the other like it.
   Put one arm up, down; the other like it.
   How would you hold a hand to read from it?

This long series of questions with careful introspection tests upon the content of consciousness constituted then my main research in the field of stuttering. Perhaps further deatils in explanation of the questions chosen is unnecessary. Three or more questions on introspection were asked at each test.

4. FINAL DETAILED RESULTS.

Final detailed results are found in the following conclusions as drawn from 1,440 answers.

In our average conversation a visual picture is created before we begin utterance. Severe stutterers never visualize at all. In direct proportion that these cases become less severe, does visualization increase in frequency, strength and continuation in consciousness before and during utterance.

When severe stutterers are free from spasms they visualize, and when they stutter they do not visualize.

When mild cases are free from spasms, they visualize, and when they stutter they fail to visualize.

In a word, when visualization is present stuttering is absent; when visualization is absent stuttering is present.

This is true not only of *each utterance*, in most cases, but is true of severe as well as mild forms as a whole.

Stutterers gain in visualization as they approach cure.

For past, present and future memories: visualization is slightly more frequent for past and future.

Therefore, stuttering is an indication of absent or weak visualization either in isolated words, occasional stutterers, mild stutterers or the severest type, either before or during speech, or both.

The slump, then, in personality which I showed last year as the main thing in stuttering as its cause and condition, is thus found by further psychological analysis, to be a slump in the power to consciously visualize.

By personality I mean as mentioned above the composite of collaborative activities that lie between the low sensory repository areas and the low motor expression areas. In other words, personality includes all those collaborative processes that lie between the sensory intake areas and the motor output areas; in a word, any unexpressed use the mind makes of its intake. Conscious visualization is a part of personality processes, then. In my last year's paper[1] the whole matter was left vague. Here something definite and constant is found. In other words, the psychoanalytical method revealed no conscious subconscious cause. Granted there is room here to "interpret" (or create according to Freudian mechanisms) a definite subconscious complex, a step which I could not feel justified in taking; I leave this to better psychoanalysts than I. For me to twist stutter phenomena to comply to a theoretical complex is unscientific, to say the least. But the psychological method—as represented by this paper—shows a definite constant cause for all the phenomena of stuttering.

FAULTY VISUALIZATION EXPLAINS ALL PHENOMENA.

Upon this basis of an involved visualization all the intricate phenomena of stuttering may be explained. Let us take some of these up in detail.

The Start.—Visualization processes are a matter of growth through exercise and development and use from the sensory area mostly of the eye. If these processes in their early start and evolution receive a setback through the treatment of people in the environment, such as interruptions of their early speech efforts, constant inattention of those to whom they speak, and persistent refusal by older people to answer questions propounded or the allowing of the little one to ask the same question without hopes of answer for a great number of times, these visualization processes receive a setback. This kind of treatment in the home is one of the chief causes of the slump of visualization processes. Another cause is hearing other stutterers interrupt their own visualization processes as they stutter; and still other minor causes may be almost any psychic trauma; these traumata, such as an operation, an accident or a severe illness, are sufficient to bring to the surface or intensify a growing lack of visualization that has been started by bad environment long before.

The Development of Stuttering.—When the habit of visualization is lessened, the action upon speech is the same as the withdrawal of an inhibiting or regulating reflex arc.

It is thus that visualization processes act like reflex inhibition. When visualization is present a higher inhibition arc is functioning and we have a normal speech as a consequent reflex expression. When and in proportion as visualization is absent, this higher inhibition arc is not functioning; and the speech thus uncontrolled flies away in spasms which we call stutter. It should be called an exaggerated or uninhibited speech reflex.

The stutter, then, is merely the externalization of an exaggerated reflex of motor speech, exaggerated through the loss of the inhibitory action of a more or less weakened visualization process.

Not only does this explain the phenomena at large but seems to be a satisfactory explanation for all its intricate minute details. Some examples may, perhaps, be wel-

* Paper read before the American Psychopathological Association. Courtesy of the *Journal of Abnormal Psychology* and of Richmond G. Badger, Publisher.

[1] Swift, Walter B, A Psychoanalysis of the Stutter Complex with Results of Synthesis.

come at this point. I say to two stutterers: "Tell your first name." One of them stutters and the other one does not. On further questioning, it is found that the one who did not stutter visualized, and the one who did stutter did not visualize.

Concrete.—These conditions are also seen when stutterers talk about concrete and abstract matters or when they promulgate some important plea that cannot be visualized. On concrete matters that can be easily visualized the stuttering is gone; and on abstract matters where visualization is hard, the stuttering again appears.

Anger.—In anger, when an intense visual picture is presented and occupies the mind, there is then no stuttering, and also in other similar situations there are periods when the individual is abandoned to some visual concept which acts in the same manner.

Singing.—We all know that stutterers can sing without stuttering. The process here is a similar one; only that there is held up over the speech before utterance an auditory image of a melody in place of the visual image as held in normal speech. This auditory image may be more easily applicable as supplying the needed inhibition reflex arc than the visual because it is nearer to the speech area.

Prayer.—For the same reason prayer is uttered without stuttering when there is faith enough in a God to hold an image of Him during utterance. There may also be other images held during prayer.

Familiar Sights.—Familiar sights are less stuttered upon than the detailing of situations that are less familiar and therefore can be less well visualized. This is also true of sights that have been recently seen or that have been repeatedly seen, or that in some other way have been made intense as pictures in the visual field.

As Cure Proceeds.—In the process of recovery where visualization is seen to increase as the stutter decreases, there is another illustration where this visualization attitude explains the whole situation. I have taken a severe stutterer and told him a story that could be well pictured, got him to work up the pictures properly by several complicated processes (which we will not consider now) and when he had them well in hand, I have seen him stand up and relate the story from beginning to end with little or no stuttering. If at any point he would trip up, the inevitable confession would be that at that point he dropped the picture, or, in other words, the visualization could not be held over in its inhibitory action; and, therefore, the stutter came. On further request to hold it over that point, the same passage would be again expressed smoothly if he succeeded in holding the picture.

This constancy, this presence and absence of the picture, its presence to make smooth talk and its absence to cause stuttering, is so constant at every turn of the situation, that I would offer it as a new interpretation of all these phenomena. I know of no other interpretation that can *explain everthing under one head* as this absence, weakness or interruption of visualization processes.

Terminology.—We have found in our orientation tests that in a vague way the visualization was at fault. We have also found in normal individuals that a marked visualization was an automatic process that preceded speech, and lasted during utterance; and we have found in the long series of stutterers that visualization is entirely absent in severe cases; that it is weak in milder forms; that it is intermittent in most cases, and that on words that are smooth it always appears, and in occasional stutter it is as occasionally absent.

We have also found that the form of visualization common in normal speech is the visualization of eye sensations; that in unusual situations we may have visualizations from other sense areas, such as the ear, taste or smell, but these are the *rare exception.*

From all this data it would naturally follow that some sort of term is needed to designate this condition. Last year I probed to find such a term without much success.

At present I see no reason why it should not be called an Asthenia; it is surely the weakening of a mental process that is strong in normal individuals. The evidence here presented shows that. I doubt whether there is any marked pathological change, since the individual may be educated out of it; but this does not necessarily follow, as proven with my dog in Berlin.[2] As a general designation, then, I should consider Asthenia as apropos.

One objection to this is that the weakness is by this terminology lacking in localization. Our data above has shown us that the location of the trouble is visual; that is, it is situated about a center of sensory registration that deposits data from the eye; this must naturally then be located somewhere in or near the cuneus. We could, therefore, add to the terminology this idea of a minute localization and call it a Center Asthenia.

Some may prefer to carry the matter one step farther and add the name of the center in which this weakness is located, but I fear if I take this step and complete my terminology by the word "Visual Center Asthenia," it will, as such, not cover quite all the cases, for I find that sometimes the visualization is absent in other areas as well, and also the holding of an emotion of pleasure or pain and of other dominating mental attitudes that are sometimes visualized would not, therefore, be included. I would, therefore, retract the broader claim in order to place the term on a conservative basis and call the essence of the lesion simply no more or less than a Center Asthenia. As well as Visual Asthenia, the following terms might be considered as applicable: collaborative center asthenia; picture-producing center asthenia. We say neurasthenia when the trouble is not in the nerves as such, so much as it is in the collaborative centers. Here in stuttering the trouble is also collaborative, and we can be still more definite than that and say the trouble is with the collaboration of visualiza tion. So, if I were forced, however, to choose one term from all these, my choice would be "*Visual Center Asthenia.*" This indicates a new and rational treatment.

Summary.—Psychoanalysis reveals stuttering as some vague trouble in the personality. Psychological Analysis shows stuttering is an absent or weak visualization at the time of speech. This new concept of stuttering as faulty visualization may be called Visual Center Asthenia. This lack or weakness in visualization accounts for all the numerous phenomena of stuttering in severe, medium, or mild cases. A new treatment is indicated.

[2] Swift, Walter B., demonstration eines Hundes, dem beide Schafenlappen xtirpiert worden Sind. Neurologisches Centralblatt, 1910, no 13.

Effect of Smoke on Trees

At the Royal Experiment Station for Forestry at Tharandt, in Saxony, there has recently been built a new "Smoke Experiment House." Here Mr. Wislicenus has been studying the effects of smoke on vegetation, particularly trees.

An article in the July number of *Rauch und Staub* (Smoke and Dust), published at Dusseldorf, gives an account of the result of his investigation of the "effect of dilute acid gases and acid fog on plants." It is now well-known that sulphurous acid gas is the most dangerous constituent by far of ordinary smoke. We read:

"Smoky air injures especially sensitive plants such as firs when it contains only one cubic centimeter per cubic meter of SO_2, i.e., one millionth part. The experiments begun at Tharandt in the little old house continue in the new Smoke House, which is especially arranged for bi-section study. The new arrangement permits the placing of the experimental plants within the glass walls of the house in such manner that only one half of the portion of the plant above ground extends into the gas room, while the other half can continue to flourish undisturbed in the open air. In this way, by the direct comparison of the sick and the sound halves of the same specimen, errors due to individual differences between experimental and control plants may be avoided. There are other improvements also. The aids to experiment in the new Smoke Experiment House have made possible reliable observations of 'artificial smoke injuries' under measurable conditions of experiment (definite mixtures of air and acid gas, climatic conditions like those in the open air, effects of light and shade, etc.)

"Definite information has been gained not only as to the external symptoms but as to the essentially internal processes of the injuries occasioned by the by-product gases, or a confirmation of former observations. Even if single physiologic-chemical problems and those of plant pathology are not comprehensively answered, yet for such questions exact points of support have been gained."

Dr. Wislicenus then proceeds to tabulate the results of his studies thus far obtained. In the first place he discovered that pure sulphurous acid gas when greatly diluted with air is capable of injuring plants only when the leaves of "needles" are engaged in active assimilation, as in spring and summer and by daylight. The stronger the assimilative activity of the plant the more susceptible it is to such injury.

"1. The gaseous sulphurous acid is a specific assimilative poison for plants, a sharp *indikator* of the phytosynthetic process. (Note.—I do not find *indikator*, but judge it to mean *inhibitor*.) In the winter condition of rest, and at night, or in deep artificial darkness in summer, the plant is non-sensitive to sulphurous acid. Even light which is diffused or much dimmed lessens the danger from smoke as well as the activity of the assimilative process.

"2. The effect of injury from smoke is therefor entirely dependent upon the one hand, on the co-operation of light and the degree of its intensity, and, on the other hand, upon various vegetative conditions (according to time of day and of year).

"3. At the time of the change from the winter state to summer vegetative conditions, the sensitiveness of the leaf (or needle) organs begins to appear, first with the advancing development of the young leaf organs (beginning of June to middle of month), but at a different stage of leaf-development in different plants, whether deciduous or evergreen.

"3. Of the conifers the pine or Scotch fir (Kiefer) seems to be most 'smoke-hardy,' as is the case in Nature; the fir (Tanne), at least at the beginning of the second age-period, being strikingly resistant where there is a low percentage of acid, but one continuously present; the pine (Fichte) is by far the one most threatened. These findings may be accepted as conclusive for the pine (Fichte), but not yet conclusive for the fir (Tanne). (Note.—the German-English dictionaries are rather careless in the way they say "pine or fir.")

"4. At the period of strong vegetative activity the tops of the conifers (especially the new growth at the tips), are least resistant.

"5. At the period of lively vital activity in the pine (Fichte) the new growth in bright light seems most sensitive, but the older needles of a year's growth are also very easily injured. This relation is reversed at the period of not fully developed formation of substance in the needles. Correspondingly, the older year's growth of needles in the pine (Fichte) suffers most in the developing stage in the spring of the year.

"6. If the needle-axes (leaf-stems) are still in a tender condition at that time they will be killed. Then there will occur the twisting (Krämmung) of the sprouts which has hitherto been supposed to be due to the action of a late frost instead of to smoke.

"7. Great regularity in the degree of resistance is shown by any given kind of plant, especially for birches and firs (Tanne), but with some uncertain exceptions in the case of the latter. On the other hand the individual degree of resistance is so dependent upon the vegetative condition of the moment (leaf development, flowering time), that both real and apparent contradictions to the resistance rule may proceed from this cause.

"8. Finally, the arrangements of the Smoke Experiment House are adapted to secure a more exact measurement of the oxidation of the sulphurous acid in the air to sulphuric acid in the presence or absence of the oxidation catalyzer which is found in the active chloroplast of the plant."

Cancer—a Disease of Many Forms

People commonly think of cancer as a single definite disease, as distinct and uniform in its nature and symptoms as appendicitis or typhoid fever. This is a misconception. It is nearer the truth to regard "cancer" as the name of a group of quite different diseases which have one feature in common. It has been said that the layman's conception of cancer is of something very indefinite, very portentous, quite hopeless, a disease which always effects someone else than himself, and about which he carries no immediate interest or responsibility. If this is a fair statement, the layman is wrong on practically every count, and his error and confusion is probably due, in no small part, to the failure to take account of the many forms of cancer. If this were done, perhaps the patient would not so frequently yield to despair and throw away the excellent chance of cure that exists when the disease is first discovered.

As a matter of fact "cancer," in the light of modern knowledge of human ailments, is almost as general and vague a term as "fever." The word covers a number of entirely distinct diseases, differing widely in their origin, symptoms, treatment, and curability. The various kinds of tumors have little in common except that they are all forms of new and lawless growths of body cells.

This false notion of cancer as a single disease has probably hindered progress toward the understanding and control of the various diseases which are conveniently grouped under that term. All forms of cancer are aspects of new and lawless cell growth, and it is the inner nature or "cause" of such growth that we do not yet understand.

The essential point for the man in the street is that each different kind of cancer is a separate disease. If he is so unlucky as to be attacked by any one of them, it would be well before becoming discouraged to go and find out which form he has. If he is taken with a "fever" and it happens to be German measles, his outlook on life is quite different than if it chances to be virulent small-pox. So, also, a "rodent ulcer" on the face is quite different from cancer of the stomach. And lastly, while one is a more serious disease than the other, there is always hope if it is recognized and treated at once. Why not give the surgeon the same chance with cancer as he has with appendicitis? Suppose all symptoms of that disease were neglected and hidden until the appendix had burst? Doubtless the surgeon would still save a certain percentage of cases, but would the record be anything like it is now? It is the intelligent co-operation of the patient and the family physician that has conquered appendicitis, and the same weapons are even more needed in the fight against cancer.—*From the Journal of the American Medical Association.*

Fig. 1.—An instance of complete protection: A helmet struck by a bullet which ricocheted without penetrating.

Fig. 5.—Struck by five shrapnel bullets and splinters: A helmet whose wearer was only slightly wounded, thanks to its protection.

Fig. 6.—Hit by a shell-splinter, whose force it checked: A helmet whose wearer did not succumb to the wound.

The French Life-Saving Helmet*

Which Has Greatly Reduced the Number of Head Wounds

THESE remarkably interesting photographs illustrate some tpyical cases in which the lives of French soldiers have been saved by the new steel helmet, which protects the head against shrapnel bullets and splinters dropping from above. These cases and many others of the same kind, which the soldiers who wore the helmets described to their comrades, have done much to make very popular this new form of head-gear, which at first the men complained was rather heavy to wear. They now know that this weight—which is not so great, after all, as it varies between 670 and 750 grammes, according to the dimensions—is an indispensable means of protecting them. Its efficacy has been recognized by the military authorities, and now the French cavalry wear it as well as the infantry. The French "Adrian helmet," to call it by the name of its inventor, proved the one and only covering which afforded adequate protection to the head. It is interesting to note that already two million and a half helmets have been made and distributed, and the French government has sent a number round to the Allies on trial. The Belgians will start wearing this helmet shortly, painted khaki to go with their uniform. A lion's head will take the place of the grenade on French helmets.

As the greater number of the men at the front in France and Belgium are located in trenches, it is the head that is particularly exposed, and the casualties from such injuries have been unusually numerous and severe, especially in view of the disrupting effect of the high velocity modern bullet which literally shatters the skull. It is these considerations that has brought about the revival of this piece of medieval armor, which has fully demonstrated its value. The helmet is stamped out of tough sheet steel, and made in two pieces, the crown and the rim, and it is provided with a lining that makes it comfortable for the wearer. A crest is added, which is not only ornamental, but tends to greatly stiffen the crown and give additional protection. National or regimental insignia are fixed on the front of the helmet, and they are painted any desirable color.

The new French helmet was the means of avoiding many wounds during the great offensive in Champagne and Artois. Head-wounds, so frequent in this war, will now be less dangerous, and in many cases entirely prevented. The photographs here reproduced show helmets which have all been hit, and have saved the wearers from certain death. The crest of helmet No. 1 was cut by a bullet, which, after hitting the back part of the crown, ricocheted without penetrating any further. This is a case of absolute protection. Helmet No. 2, on which a splinter of a large shell fell, had its crest torn off owing to the violence of the shock; the air-hole which it covers was laid bare. The soldier who wore it fell violently on the ground and bent its brim. He told the photographer that his only injury was a large bruise on his skull. He would certainly have been killed if he had not worn his helmet. Helmet No. 3 was hit in the crown by a bullet, which, coming into contact with the sheet steel, was deflected from its normal course and thrust outward, making yet another hole in the metal near the crest. The man who wore Helmet No. 4 was a sniper, and was lying down at the time, when he was hit by a bullet, which, instead of hitting him perpendicularly, was thrown against the inner side of the crown, pushing back the metal on a length of four centimeters, stopping between the lining and the steel. No. 5 was hit by five shrapnel bullets and splinters. The bullets bent the steel without perforating. One splinter made a hole, but the shock was diminished, and the wound was slight. The splinter of shell which indented helmet No. 6 managed to tear the steel in the cavity produced by the shock; but no serious injury resulted.

* From the *Illustrated London News*.

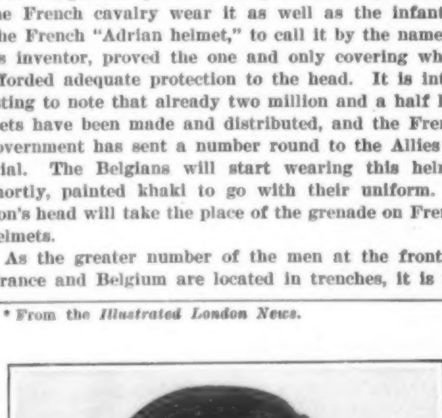


Fig. 4.—A French sniper's helmet that saved his life: Showing marks of a bullet that struck it as he was lying down.

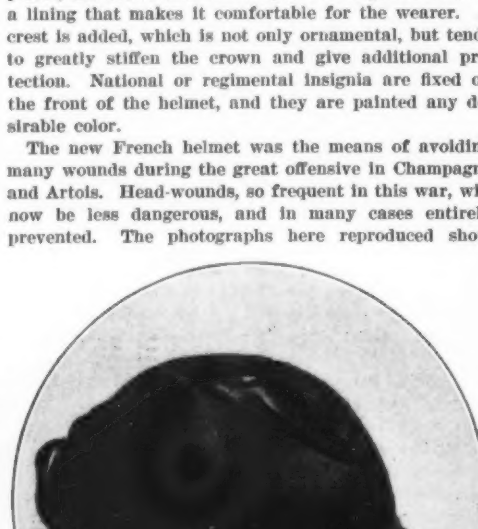


Fig. 2.—With crest torn by a shell-splinter and brim bent by the soldier's fall: A helmet that saved its wearer's life.

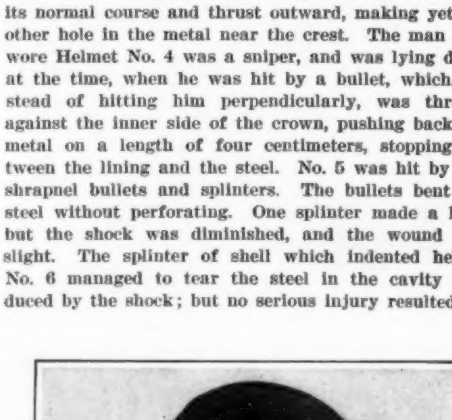


Fig. 3.—Showing the holes of entry and exit: A helmet pierced by a bullet which was deflected out again.

The Noise of a Bullet

A PERSON in the line of fire of a modern gun hears distinctly two successive detonations. According to his distance these may be close together or farther apart, and they may or may not be accompanied by a continued whistling or roaring sound. The two noises, as is noted by Col. Agnus, of the French army, in the *Revue Scientifique* (Paris), are familiar to target-keepers in rifle matches, who usually suppose them to be caused respectively by the discharge of the gun and the impact of the bullet on the target or the ground. This is incorrect. Col. Agnus tells us that the first noise is the discharge, but the second is due to disturbance of the air by the bullet. When the projectile starts, it is moving faster than sound. It slows down, and when it has gone about a mile and a half the sound-wave begins to gain on it and finally passes it. To these facts are due the phenomena of the bullet's noise, as is shown by Col. Agnus in a mathematical analysis. In the first place, the two noises will be heard only with modern high-powered weapons, whose bullets move faster than sound. If the observer is nearer than about 300 feet the two sounds merge into one. Farther away they are heard farther and farther apart, and at about a mile and a half, the point where the velocity slows down to that of sound, a continuous whistle or roar is heard, first between the two detonations and farther away, lasting longer and longer. Of course, if the projectile is a shell, its subsequent explosion adds other noises. In closing he writes:

"One thing that has always struck the attentive reader is to find in all conscientious narratives of the fall of meteors, without exception, the mention of a formidable detonation. In general, it is stated that the bolide exploded—that it burst with a terrible noise. And if it is found later in a field it is discovered that there was no explosion at all, and often that it buried itself in soft earth, which must have lessened the noise of impact very much, the detonation, in my opinion, is very naturally explained.—*The English Mechanic.*

Discharging hydraulic material to form the dam.

The concrete culvert built through the site of the dam.

Building a Big Earth Dam

Interesting Details and Methods of Construction

The Calaveras reservoir and dam is located in Alameda and Santa Clara Counties, California, about 36 miles from the city of San Francisco, and its purpose is to augment the domestic water supply of San Francisco. The details of the reservoir and catchment area are of special interest. The capacity at flow line is 53,000 million gallons, and the area of water surface at flow line is 1,833 acres. The average depth is 88.7 feet, and the tributary catchment area 100 square miles at present, while with later diversion of Upper Alameda it will be 140 square miles.

The elevation of catchment area ranges from 800 to 4,000 feet above sea level and the average normal precipitation is about 28 inches per season. The population in catchment area is 1.08 per square mile. The character of catchment area is mountainous and rugged and unfit for any kind of agriculture, while the character of stream is torrential, varying from 2 second-feet in summer to 10,000 second-feet in storms.

It is of interest to note that the reservoir was acquired by the Spring Valley Water Company about 1875 to provide for future development, at which time without much exploration an earthen dam 150 feet high was proposed. There were serious explorations for a suitable dam site begun about 1900; and in 1905 plans were prepared for a concrete dam 180 feet high. Contracts were about to be let when the great fire and earthquake of 1906 interfered. Further explorations were made in 1910-12 and plans for a rock fill dam 205 feet high, somewhat below the site for a concrete dam, were prepared and rejected. Subsequently plans were prepared for a concrete dam 240 feet high with a huge hydraulic earth fill on its upstream side. This location was practically the same as the first concrete dam. These were similarly rejected, and final plans for a hydraulic fill dam were adopted in June, 1913.

The choice of an earthen dam was made for the reason that this is a region of seismic disturbances, and the San Andreas rift of 1906, with a lateral movement of about 8 feet, passed through two earthen dams without damage. The final location is about one half mile upstream from that of the proposed concrete dams. The dam is of the hydraulic fill earthen type and the elevation of the crest is 800 feet above sea level, while the elevation of the flow line is 790 feet above sea level.

The maximum height of the dam above stream bed is 220 feet and the maximum height above bedrock is 240 feet, while the length of crest is 1,260 feet, the width of crest being 25 feet and the upstream slope about 3 : 1, while the downstream slope is 2½ : 1 with 20-foot berm at midheight. This dam has a thickness at base of 1,312 feet and its cubical contents will be 3,100,000 cubic yards, the upstream face being paved with concrete. On account of its great size several years will be required to complete the work, and provision is necessary to pass floods which may occur during the season of heavy rains, which is from December to April, during the period of construction.

For this purpose a large concrete culvert was constructed through the base of the dam on the west side of the channel. This structure is 1,312 feet long and rests for its entire length on bedrock, a tight serpentine of varying hardness. In order to keep bedrock contact and retain grade, the invert of the structure is in places 12 feet thick. The interior section of the culvert is horseshoe shape, with an area of 315 square feet, equivalent to a circle 20 feet in diameter.

At the entrance of the culvert there is a low circular weir 40 feet in diameter, which may be raised by flash boards in time of small flow. The purpose of the weir is to regulate the pond above the dam for hydraulic operations. The culvert and appurtenances contain 19,987 cubic yards of concrete.

Provision to prevent seepage under the dam was made by removing the overburden and exposing bedrock over a strip 140 feet wide along the center line of the dam. A cut-off trench 25 feet wide and 8 feet deep was excavated into the bedrock directly under the crest of the dam, and the center cut and cut-off trench are carried up the sides of the cañon as filling in the dam progresses.

The sluicing operations are of a great deal of interest as the material to be placed in the dam is borrowed from the hillside adjacent to the dam, and from the valley floor in the reservoir site. So far material has been taken solely from the valley floor and it is a mixture of gravel, sand and clay, the percentage of clay ranging from 20 to 50 per cent. The size of the gravel ranges from the size of a pea to boulders 12 inches in diameter. The material is excavated by means of hydraulic jets, with nozzles ranging from 1¾ inches to 5 inches in diameter, with a pressure of from 60 pounds to 80 pounds at the jet. In easy-working material, groups of small nozzles, attached to 4-inch hose, are used so that moves may be quickly made.

In the more difficult material, or where high banks are maintained, two great monitors which concentrate a large volume of water under high pressure are used. The small jets may be moved in an hour or two, while it takes from one half day to a day to move the giants into new positions. After the material is excavated it is carried in suspension down sluiceways to a sump where it is picked up by 12-inch centrifugal dredger pumps, and carried to either toe of the dam in 14-inch pipes.

The material discharged at the toes runs toward the center of the dam, where a pond is maintained at the desired height. Large gravel stops at the toe, the water graduating the material in fineness as it approaches the central pond, where only clay is deposited, and thus a core of clay is formed, the thickness of which is regulated by the central pond. Gratings to remove rocks over 5 inches in diameter are maintained above each sump, as rocks larger than 5 inches interfere very seriously with the operation of the 12-inch mud pumps.

For the hydraulic work water is furnished to the jet by two-stage 10-inch centrifugal pumps. Booster pumps are put in the mud lines for each 60-foot lift due to increase in elevation at point of discharge and friction in mud lines, which varies with the position of the borrow pit.

A Method of Detecting Various Mineral and Alkaloid Poisons in Water

The methods here described take less than three hours and require a liter of water. If the water is not clear it is not filtered until after it has been acidified with some drops of nitric acid, to dissolve any deposit. If there is much deposit it is best to treat the nitric acid solution of it separately. Half a liter of water is placed in a separating funnel, made alkaline with sodium carbonate solution, and shaken with 20 cubic centimeters of chloroform, which is subsequently separated off and dried with anhydrous sodium sulphate. It is then placed in two watch-glasses and evaporated on the water-bath. Then 2 cubic centimeters of 10 per cent sulphuric acid are added to each, and some drops of Bouchardat's reagent to the one and Sonnenschein's reagent to the other. The appearance of a precipitate indicates an alkaloid. If an alkaloid is present another liter of water is similarly treated, and the chloroform is divided into five portions on watch-glasses. To the first residue from evaporation five drops of pure nitric acid are added: a red coloration indicates brucine, and violet colchicine. One drop of pure nitric acid is added to the second, which is then evaporated to dryness; this oxidation is repeated twice. An alcoholic solution of caustic potash is added to the residue: a violet coloration indicates atropine. Some drops of Fröhde's reagent are added to the third watch-glass; a violet coloration indicates morphine. Mandeline's reagent or sulphuric acid containing bichromate is added to the fourth; a violet coloration indicates strychnine. To the fifth watch-glass some drops of pure sulphuric acid are added: a persistent yellow coloration indicates colchicine, while a yellow coloration becoming carmine indicates veratrine. The alkaline water, separated from the chloroform, is acidified with acetic acid, and iron perchloride solution is added, and then ammonia drop by drop. The precipitate of iron sesquioxide containing arsenic and antimony is filtered off after boiling. If the filtered liquid is blue, copper is present. The precipitate of iron sesquioxide is washed, dissolved in sulphuric acid, and the solution is put in a hydrogen apparatus with platinized zinc and sulphuric acid. The current of gas evolved is led into silver nitrate solution. If there is a black precipitate it is dissolved in tartaric acid, warmed, acidified with HCl, and treated with H_2S. An orange precipitate is formed if antimony is present. The filtrate from the black precipitate is treated with HCl, added drop by drop, and the silver chloride is filtered off; then excess of Bougault's reagent and decinormal iodine are added: a black precipitate or a brown coloration indicates arsenic. To detect barium 2 cubic centimeters of sulphuric acid are added to half a liter of the water. Barium is absent if no precipitate has formed in five minutes. If a precipitate has formed it may be washed, treated with a solution of ammonium tartrate to eliminate lead sulphate, and then introduced on a platinum wire into a colorless flame; a green coloration indicates barium. The filtrate from the sulphuric acid precipitate is distilled with copper wire; to the distillate are added iron sulphate, iron perchloride, and soda solutions, and finally hydrochloric acid: a blue precipitate indicates cyanides. If the copper wire turns white mercury is present. The acid liquid is warmed and treated with H_2S: a black precipitate indicates mercury or lead. If on treatment with nitric acid a black insoluble residue is obtained mercury is present. Ammonia is added to the nitric acid solution and some drops of hydrogen peroxide. The liquid is filtered, the filter is washed with nitric acid and alcohol, excess of saturated sodium acetate is added to the filtered solution, and then some drops of potassium bichromate solution; if lead is present a yellow precipitate is formed. An excess of saturated sodium acetate solution is added to the liquid separated from the black sulphides, and it is then warmed and treated with sulphuretted hydrogen; a white precipitate indicates zinc. If the color is doubtful the precipitate is filtered off, dissolved in HCl, a little sulphurous acid is added, the solution is boiled, soda solution containing potassium cyanide is added, and then sodium sulphate: a white precipitate indicates zinc.—*Journal de Pharmacie et de Chimie.*

Cleaning a Steel Knife

If a steel knife is much stained, take a piece of raw potato and dip it in powdered bath brick. Rub the blade of the knife well with this, and then dip in hot water and wipe dry. You will be surprised at the brilliancy of the steel.

The Transformation of Pure Iron*

A Discussion of Certain Physical Properties, and the Question of Allotropy

THE general discussion on "The Transformation of Pure Iron," held on Tuesday, October 19th, 1915, in the Faraday Society, developed into a re-trial of the case, "Allotropists v. non-Allotropists," and concerned predominantly the general definition of allotropy, certainly quite as much as the peculiar phenomena displayed by iron. At such discussions as this there is a president, but no jury; no verdict is given, no decision is arrived at, and when the meeting disperses, the question generally stands adjourned. Mr. A. E. Oxley, M.A., D.Sc., of Sheffield University, had prepared a paper bearing the above title, and this communication he had enlarged by a welcome introduction.[1] He found some support and more criticism in the meeting, and a large number of distinguished metallurgists, unable to be present, communicated further critical comments. Whether or not the new theory of Dr. Oxley will eventually bring Allotropists and Carbonists together, as President Sir Robert Hadfield put it, remains to be seen. It will certainly help to clear the ground.

As we have already stated, the discussion, in the first instance, all turned about allotropy. The term "allotropy" was introduced a century ago by Berzelius to indicate what Lothar Meyer later aptly characterized as "physical isomery," the occurrence of certain elements in different forms and states, in allotropic modifications. The term was soon applied also to compounds, and it has, unfortunately, been defined in so many ways since that it is now difficult to say what really constitutes allotropy. It is stated that carbon, sulphur and phosphorus are known in allotropic modifications, meaning that each of these substances can crystallize in different systems, that they are thus polymorphous, and that the different modifications differ in physical and also in chemical properties. The change of oxygen into ozone ($3O_2 \rightarrow 2O_3$) is regarded as a case of chemical allotropy. When metals assume different properties under heat treatment, and several modifications can apparently exist in equilibrium over a certain range of temperature, some scientists speak of dynamic allotropy. E. Cohen even goes so far as to consider every metal as representing an unstable mixture of several modifications. Our own impression is that in such views the influences of small impurities, which baffle research, may be overlooked.

Dr. Oxley endeavored to go to the root of the matter. What is the nature, he asked, of a medium that has crystallized? Was it not merely one of extreme molecular association, which, apart from the effects of the mutual influences between the molecules, would be identical with the molecules of the fluid state? When that were granted, and when the variations of molecular association over wide ranges of temperature were considered, then each state of molecular associaton at each particular temperature might be regarded as a new allotropic modification, and there was no particular reason to waste time on the A_2 and A_3 transformations of iron. On the other hand, if that view were rejected, then two kinds of allotropy would have to be distinguished, one involving a discontinuity at a specified temperature, the other involving a gradual transformation over a more or less wide range of temperature. The first type was the heterogeneous two-phase allotropy, the second, the one-phase homogeneous allotropy of Benedicks.

In the binary state diagram (heterogeneous equilibrium) no consideration was taken of the internal molecular (homogeneous) equilibrium within each phase (Benedicks). To distinguish experimentally between the two types, and to prove that a discontinuity existed, demanded an enormous tax on experimental ability, and the rival advocates would hardly be satisfied finally. Dr. Oxley showed this by exhibiting Honda's curves of the variation of magnetization with temperature. The fusion point might be thought to be the nearest approach to a mathematical discontinuity defining the two-phase type of allotropy; but the phenomena of liquid crystals, studied by Lehmann and others, indicated a continuous marshaling of the molecules into a flowing space-lattice which eventually became a rigid crystal, and these liquid crystals exhibited one-phase allotropy on cooling, and two-phase allotropy on heating. Thus, properties might change rapidly—i. e., within a small temperature interval—without there being distinct evidence of discontinuity.

Dr. Oxley was, therefore, unable to draw any sharp distinction between the two types of allotropy; the phenomena could be ascribed, he thought, to some intramolecular change, and depended, not upon what happened at a particular temperature, but upon the sum total of what happened during a temperature interval. He considered that the molecules of crystalline substances—and even of liquid substances—were in a distorted state, the distortion being very slight, and due to the restraining forces exerted by neighboring molecules. The molecules of the liquid and of the crystalline grouping were, hence, not quite identical; that slight distortion, however, did not indicate allotropy. But if the restraining forces were withdrawn—Dr. Oxley admitted subsequently that this was hypothetical, and practically impossible probably for solids and liquids—and if the crystalline structure then differed in configuration from a free molecule (which had originated in some other way by a chemical or physical process) either as regards the integral number of atoms in the molecule or the relative distribution of those atoms (which might be of the same number), then he would say that the substance exhibited allotropy. On the other hand, molecules of exactly the same configuration might be packed into quite distinct crystalline aggregates (Barlow and Pope), and that difference of crystalline symmetry would not necessarily imply allotropy. One had to distinguish between the forces holding the molecules in position in the crystalline structure and those holding the atoms together in the molecule; and as the latter forces seemed to be comparatively larger—thermo-chemical evidence was given later—the rarity of allotropy was not surprising.

Discussing the β and γ transformations of iron and magnetic properties from this point of view, Dr. Oxley remarked that according to P. Weiss, the iron molecule consisted of two atoms throughout the temperature interval of stability of the β and γ forms, and that, therefore, through the transformation from paramagnetic γ iron to ferro-magnetic β iron, there was no change in the number of atoms in the molecule. This conclusion of Dr. Oxley was based on old papers (1907) of Weiss, and is not in accordance with what Weiss himself stated at Manchester, when he spoke of β iron being probably Fe_3, γ iron Fe_2, and δ iron Fe_1. Professor Weiss had himself sent a communication to the discussion on Tuesday, October 19, 1915, and in this he stated that recent work had not supported the early conclusion just mentioned, because the value of the Curie constant had had to be corrected; he agreed with Dr. Oxley, however, as to A_2 not being an allotropic transformation. But Dr. Oxley, in explaining the determination of the Curie constant, showed that Weiss had, in supporting the Fe_3, etc., really based forced assumptions upon his own experimental data for the sake of being true to his magnetons—which Dr. Oxley does not accept. Dr. Oxley further considered iron allotropic in so far as $Fe(CO)_5$ was diamagnetic and $FeCl_3$ paramagnetic, but that was not an allotropy of the oxygen-ozone type. The simple constitution of the iron molecule made it improbable that changes in the physical properties of iron could be due to a rearrangement of the atoms in the molecule. Two atoms might conceivably be slightly displaced relative to one another as the transformation points were being passed, but the resulting iron molecules could not possess a new set of properties. Moreover, if magnetism were to be ascribed to molecules, the appearance of ferro-magnetism on cooling could not be explained on this view; ferro-magnetism demanded intermolecular forces (the forces of crystallization), and though intermolecular and intramolecular forces were no doubt inseparable, and though both underwent small changes in the regrouping of the molecules, the molecules of β and of γ iron should be identical if the intermolecular restraining forces were abstracted. A change in the closeness of packing of the molecules, without affecting the crystalline symmetry, would sufficiently explain A_3. If the cooling through A_3 were accompanied by a closer grouping of the molecules in the direction of spontaneous magnetization, then the increased interaction between the molecules would give rise to spontaneous magnetization.

Challenged afterward by Dr. Carpenter as to how this view of a contraction was compatible with the expansion of 0.086 per cent observed by Benedicks on passing through A_3, Dr. Oxley drew a diagram of molecular magnets, consisting of dashes and short gaps, — — —, in a row, the next row underneath being at a distance greater than the length of one molecular magnet. This may be in accordance with Ewing, but we do not understand why the rows should not be close enough to allow of mutual influences between the magnets of different rows, while Dr. Oxley wished to confine the influences to the magnets of the same row. There might be contraction in that direction, he said, but expansion in others, and the contraction would not be inconsistent with magneto-striction.

The thermal energy, he continued, evolved on cooling through A_3 was the heat of transformation from a more open to a closer-packed cubic system, with probably a small contribution from intramolecular adjustment resulting from the change of packing. It was in accordance with his view that this heat evolution was small—equal to 1.4 gramme-calorie, according to Arnold—and that the latent heats of fusion of metals were also small (13 gramme-calories for bismuth, 14 for cadmium and for tin, 5 for lead, 22 for silver, etc.) while the exothermic heat changes of chemical allotropy and of isomery were very large; *e.g.*, 96 grammes of ozone = 96 grammes of oxygen + 52,900 gr.-cal., or 79 grammes of dipropargly = 78 grammes of benzene + 100,000 gramme-calories. Dr. Desch questioned these figures; the heats of fusion, he pointed out, were given per gramme of metal, the other calories per gramme-molecule; expressed in all cases per gramme-atom, the figures for ozone would become 9,866, and for bismuth 2,704 gramme-calories, while the transformation of gray into white tin involved 1,133 gramme-calories; thus the disproportion was much smaller than it appeared. In the case of the A_3 change, the 1.4 should really be multiplied by the atomic weight of iron, 55.84; but Dr. Desch considered the 1.4 itself much too low.

Prof. Carpenter, who opened the discussion, had already expressed the same opinion as to the 1.4; the rate of cooling had been far too rapid in Arnold's experiments, so that there would be super-cooling. As regards the general problem, he stated that it did not much matter whether the transformations were called allotropic or not; there were certainly profound changes in all properties. The transformation A_2 was no longer considered allotropic; but Dr. Oxley also attacked A_3. Iron might be polyatomic or diatomic (Weiss); but there was no proof for it. On the other hand, the X-ray researches of Bragg seemed to dispense with molecules; they disclosed only atoms and crystals, and in the case of rock-salt, e. g., a Cl might belong to any Na near it. Though Bragg had, so far, only studied one metal—copper—the crystals of that metal seemed to contain only atoms, not any molecules, and for other reasons as well the metals mercury, zinc, cadmium were considered monatomic. The views of Oxley would hardly account for the profound changes which he (Carpenter), working in conjunction with Stead, had observed in very pure electrolytic iron (which had been heated to 900 deg. Cent. for days in a vacuum in order to expel hydrogen) on slightly raising the temperature. Heated to 910 deg. Cent., the fine, small crystals changed into big crystals, which, at 915 deg. Cent., again increased in size. On several slides the transition of the one type of crystals into the other, which was a matter of a few seconds, could distinctly be seen. These observations, it should be noted, were only made with a very pure iron, almost free from carbon.

Dr. J. A. Harker drew attention to the fact that the latent heat of fusion of iron did not appear to be known, and it was altogether regrettable how scanty our knowledge on these matters was. It should not be so difficult to devise a suitable calorimeter, and if calorimetric determinations were then made with specimens of the same iron in the different states, we should really learn something about the thermal changes. Sir Robert Hadfield welcomed this suggestion, and expressed his readiness to provide means for such an investigation. Prof. J. W. Nicholson agreed that Bragg's researches made it difficult to conceive a molecule; thus, we should have to accept the possibility of changes in the atom, and that would suggest atomic allotropy. Dr. Oxley, however, in replying, remarked that the researches of Prof. Bragg and Mr. W. L. Bragg still admitted of drawing boundaries round complex molecules, and that was our own interpretation of Bragg's recent work.

We can only briefly indicate the views which were expressed in the many communications received. Mr. Henry Le Chatelier regretted both that Dr. Oxley had increased confusion by proposing one more new definition of allotropy, and the practice of replacing the consideration of experimental facts by atomic hypotheses which escaped all scientific criticism; Dr. T. M. Lowry was also very emphatic on the former point. Mr. F. C. Thompson of Sheffield submitted that the work of Burgess and Crowe (1912), which he reviewed at length, had finally settled the problem of the allotropic transformations of iron in the sense of Arnold. Mr. A. McCance said he would define allotropy as a change in crystalline symmetry. The word "molecule" was, for crystals, fast being replaced by "crystalline unit," or the minimum number of atoms in space which could define the symmetry of the crystals. Iron was no exception to the rule that changes caused by purely thermal effects were continuous; changes in the closeness of the packing were not sufficient to account for the phenomena. Prof. Thomas Turner considered Dr. Oxley's paper very suggestive, but wished to adhere to three distinct phases in solid

*From Engineering.

[1] Dr. Oxley has recently presented several papers to the Royal Society on these questions.

iron. Dr. J. Stead wrote that he would welcome a definition of allotropy which was not open to doubt; but Dr. Oxley had to explain the breaking down and the rebuilding of crystals.

Prof. F. Soddy thought that Dr. Oxley would have difficulty in defining what he meant by his "molecule of a solid," though the molecule of solids and gases seemed to be sharply defined. Few people had thought about that; else it would not have required the X-ray study to show that the extension of the molecular theory to the solid state involved an absurdity. The mean kinetic energy of translation divided by the absolute temperature was the same for all the molecules; that was Avogadro's law for gases, extended to liquids by Van't Hoff. To find out the number and kind of atoms possessing this energy was easy enough for fluids, but not possible for solids, in which the atoms were anchored and did not exist in freely-moving groups. To Prof. Soddy the term "molecule of a solid" meant merely the aggregate of atoms which remained undivided when the solid was liquefied or gasified. Only one substance was known that was supposed to be allotropic both as gas and as solid—oxygen-ozone. There was little evidence that sulphur and phosphorus were strictly analogous in their modifications, and there was less evidence as regards metals. The thermal evolution or absorption in the case of metals was too small to justify drawing conclusions.

If the heat changes were large, rearrangements in the primary atomic grouping might be concluded from them; it was not safe to conclude that there were none, because the heat changes were small.

Our readers will agree that the general problem of allotropy was very much to the front during the discussion. We may have accentuated it a little at the expense of the more strictly metallurgical transformation problem. But the placidity with which the venerable molecule is being sacrificed will be a little startling to engineers, and these questions will certainly crop up in many discussions. We refrain from dwelling on the importance of the sacrifice of the solid molecule for all speculations on dissociation.

Protective Coatings for Metals*

A Review of Various Processes for the Prevention of Oxidation

By H. B. C. Allison

This brief review of some of the processes at present in use for protecting metals from oxidation will be confined to two types: first that in which the metal itself is made more resistant, usually by some chemical treatment; and secondly, that in which another metal is used as a surface coating.

In the first instance a coating is formed which must possess the following properties, if it is to be successful: It must be homogeneous, continuous, resistant to attack by acids or alkali, firmly attached to the base metal and must have a similar expansion coefficient. The ideal metal coating should also be homogeneous and continuous, but should be strongly electropositive to the base metal and should form electropositive alloys with it, so that in case of oxidation the coating will be attacked and the base metal protected.

As iron is the metal most commonly used as the base, the processes chosen will be those used for its protection, although some may be applicable to other metals.

PROTECTION BY OXIDE COATINGS.

It was known for a considerable time before any process was devised that the black or magnetic oxide formed on iron, under certain conditions, was a very fair protective coating. Attempts to control and improve this coating have led to a number of patented processes, of which two may be taken as typical.

BOWER-BARFF PROCESS.

The pieces to be treated are heated to a temperature of 900 deg. Cent. in a closed retort. When this temperature has been reached, superheated steam is admitted for 20 minutes and a coating consisting of a mixture of red and black oxides is formed. Producer gas is then substituted for the steam and allowed to act for the same length of time. After cooling somewhat, the pieces are oiled and a smooth, green-black coating is produced, which affords efficient protection from sea water, acid fumes, etc., and will stand a wide variation in temperature.

GESNER PROCESS.

This is a further development of the above process. The pieces to be treated are maintained at 600 deg. Cent. for 20 minutes, after which steam at low pressure is let in at intervals for 30 minutes. The steam, on entering, passes through a red hot pipe at the base of the retort, and is thus partially decomposed into hydrogen and oxygen. After this treatment a small quantity of naphtha or hydrocarbon oil is introduced and allowed to act for 15 minutes to reduce any red oxide, and also to carbonize the surface. The coating is said to be a compound of iron, hydrogen and carbon, and analyses have shown that a minimum of 2 per cent hydrogen is present.

It is an improvement on the Bower-Barff process in that the danger of warping, due to high temperature, is removed, the size of the piece is practically unaltered, and the tendency to scale is much less.

Both of these processes are quite expensive, but users have usually found the protection afforded of sufficient benefit to warrant the added expense.

PROTECTION BY CHEMICAL MEANS.

There is one process which may be of interest in this connection, known after its inventor as "Coslettizing."

The pieces to be coated are first cleaned as usual, either by pickling or sand blasting, and are then placed in a boiling water solution of phosphoric acid, in which iron or zinc filings are always present. The period of treatment is from one half to three hours, depending on the thickness of the coating desired. After drying, the pieces are usually oiled. By this treatment a very slight amount of the surface of the article is converted into certain phosphates of iron, but most of the coating comes from the solution itself.

This coating has been found to be particularly useful in the tropics, and is used in one instance for typewriters. It is not a complicated process or an expensive one and the finish is very durable. It is, however, subject to patent restrictions.

PROTECTION BY ANOTHER METAL.

The agent used in the majority of cases for protecting iron is the metal zinc. Zinc is strongly electropositive to iron and so are its alloys, if free from impurities. It is also readily available and may be applied by a number of processes.

HOT GALVANIZING.

The oldest process is that of hot galvanizing, which consists simply of cleaning the piece, coating with a suitable flux and then dipping in the molten zinc. The piece is usually wiped after this to improve the coating. This process has the disadvantages of limiting the thickness of the coat, of plugging any small holes, of the composition of the coating being variable, and the possibility of including injurious and corrosive substances in the coating, which may cause early failure.

LOHMAN PROCESS.

A modification of this process is known as the Lohman process. After cleaning, the article to be coated is dipped in the Lohman bath, which is a solution of hydrochloric acid, mercuric chloride and ammonium chloride; it is then dried before immersing in the molten metal, which may be any one or a mixture of a number of metals such as lead, zinc, and tin. The chief point in its favor seems to be that the junction between the iron and the protective alloy is kept free from all oxide, and, therefore, the alloy will fill all the pores and no corroding agent can be included.

It is claimed by its backers that a graduated alloy is formed so that the protective coating cannot be completely broken through except by breaking the sheet itself.

COLD GALVANIZING.

Another process which is being used more and more as it is improved is that of wet galvanizing or electroplating. In this case the article to be coated is suspended as a cathode in a suitable bath and is subject to easy control. It provides a coating of high purity and uniform thickness in general but recesses and corners cause some trouble. It is liable to be more or less porous and may contain acid which will eventually cause failure. In both of these processes, hot or cold, the coating does not become intimately connected with the base metal through deep alloying.

SHERARDIZING.

The latest process of this type is sherardizing, and it is undoubtedly the most perfect as a protection. The object to be sherardized is placed in an iron drum which is filled with a mixture of finely powdered zinc and zinc oxide, in varying proportions, and is heated in a reducing or inert atmosphere for a period of time, the length of which depends on the thickness of coating desired. The coating so obtained consists of four protective layers. Next to the pure iron is an alloy "C," rich in iron, upon which is another definite alloy "B," containing more zinc. Then there is a layer containing a number of more or less unknown alloys, and finally a layer of pure zinc. This makes a coating which is not easily broken down and which is continuous. The principal objections to its use are the high temperature to which the piece must be subjected and the increase in size which may be caused.

The theory which has been advanced to explain this process is interesting in that it may be considered as a distillation process. The zinc dust which is obtained from the zinc smelters is said to be in a state of unstable equilibrium, so that in contact with the hot iron it undergoes a change tending to restore it to the normal condition. During this change some of it alloys with the iron, thereby lowering the vapor pressure for zinc in that region. A slow distillation then begins from the zinc nearest the object to the object itself. As the alloy becomes richer in zinc the difference in vapor pressure becomes less and less and then finally becomes zero. This is found to be the case in practice. The deposition becomes slower as the time is extended.

CALORIZING.

This recently developed process makes use of aluminium as the protective metal and is of particular advantage in preventing oxidation at high temperatures. The protective action is due to the oxide formed by the action of heat on the protecting metal, rather than to any electrolytic relations between the aluminium and the base.

It has been found very useful in the case of iron utensils subject to direct contact with flames at temperatures up to 1000 deg. Cent. and also in the case of boiler tubes, for the life is increased many times by this treatment and the saving in the cost of replacements is much greater than the additional initial cost of calorizing.

SCHOOP PROCESS.

One of the most recent processes, and one of the most promising, is the Schoop process. This is applicable to the deposition of metals or alloys on any sort of an object. The apparatus consists of a pistol into which the coating metal is fed as a wire. It passes through a straightening and centering device into the nozzle, where it is fed through a burner whose temperature may be regulated from 700 deg. to 2000 deg. Fahr. The molten metal is carried a short distance by the gas current and is suddenly caught by a powerful blast of compressed air which shoots it out of the nozzle with a velocity of 3000 feet per second, directly on the object to be coated, which is held a short distance away. The coating is homogeneous, continuous, and of any desired depth, and is also exceedingly intimate.

The following explanation of the theory is given by the inventor:

"The theory is that the gaseous medium used is much larger in volume at any moment than the drop it has pulverized and is carrying, and the gas is expanding so rapidly that its temperature is far lower than that of the spray. A rapid exchange of heat, therefore, takes place between them, which consolidates the molten particles and gives them a temperature far below the melting point. If the particles arrived in a liquid state at the base with the observed velocity of 3000 feet per second, they would simply splash on the surface and largely rebound. As a matter of fact they impact and inter-penetrate freely, and the later bombarding particles unite with the earlier ones to form homogeneous compact bodies. In accounting for the observed action of the Schoop spray at the receiving base, it is supposed that the cooled particles of the metal, just before impinging with great velocity on a hard surface, are in an abnormal physical condition. Due to the heat of collision they pass directly into a vapor which condenses and solidifies on the relatively cold receiving body, penetrating by osmotic pressure the superficial pores of the base when an affinity for the latter exists, and otherwise driven in by the pressure behind it. In either case it condenses and solidifies after penetration, and is effectively dovetailed into the base. The hammering and bombardment of the solidified first coat by the minute succeeding particles is practically a process of cold working. The entrained particles liquidify and solidify so rapidly that the metal has not time to return to its natural crystallized state."

In conclusion it should be stated that there are many other processes in use which could not be mentioned in a brief review of this type. Those processes outlined were chosen as representative of the various different means used to obtain the desired protection because of their prominence, or of some new feature which they contain.

* *The General Electric Review.*

Girard Avenue entrance to the Gardens of the Zoological Society of Philadelphia.

Some Noted Zoological Parks

The Gardens of the Zoological Society of Philadelphia

By R. W. Shufeldt

THE keeping of a collection of living captive animals of various kinds, for one purpose or another, has been characteristic of all advanced peoples all over the world, as far back as we can trace the subject in recorded history.

For one purpose or another collections of living animals were kept in the cities of the ancient Greeks and Romans; at Athens, for example, they were obtained by the armies of invasion into Asia. All this forms a long and interesting chapter in history.

This likewise applies to other collections of animals, kept by still other peoples of the remotest times, of which we have but a very meager knowledge. I refer to the captured and pampered beasts which were associated with the theology of those times. These animals formed sorts of menageries quite different from those of the ancient cities of southern Europe, for they were maintained for very different purposes. Many of these animals were considered to be sacred to the gods of those early people, and many of them were venerated for their own sake and for the various qualities they were supposed to possess, as those of power, of their resemblance to man or of their influence over his fate or the elements, and for other reasons.

As one civilization succeeded another, these menageries in time came to be represented by the modern Zoological Garden, so that in these days a great many cities, in various parts of the world, support institutions of this kind. Among numerous others I may mention those of Amsterdam, Antwerp, London, Philadelphia, Berlin, New York, Washington, Cincinnati, Paris, Marseilles, Melbourne, Stellingen, Giza, Rotterdam, and a great many others, both public and private ones. One of the latter is the famous park at Woburn Abbey maintained by the Duke and Duchess of Bedford, and another the Tring Park by the Honorable Lionel Walter Rothschild and Dr. Ernst Hartert.

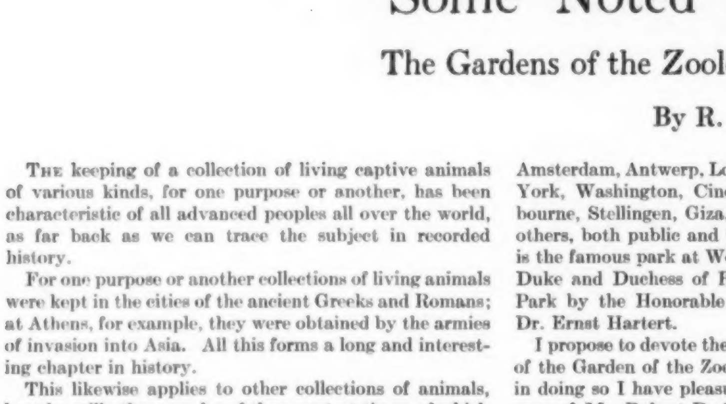
I propose to devote the present article to a brief history of the Garden of the Zoological Society of Philadelphia; in doing so I have pleasure in acknowledging the assistance of Mr. Robert D. Carson, its most efficient superintendent, and Dr. Herbert Fox, who has charge of the society's Laboratory of Comparative Pathology.

These gardens were the first of the kind established in this country, and it was through the foresight and energy of Dr. William Camac, a rich and prominent citizen of Philadelphia, that the idea of their establishment was conceived. His plan to establish a "Zoo" in his native city took shape in his mind some time in the decade following the middle of the last century, and without difficulty he soon interested a number of his friends in the project.

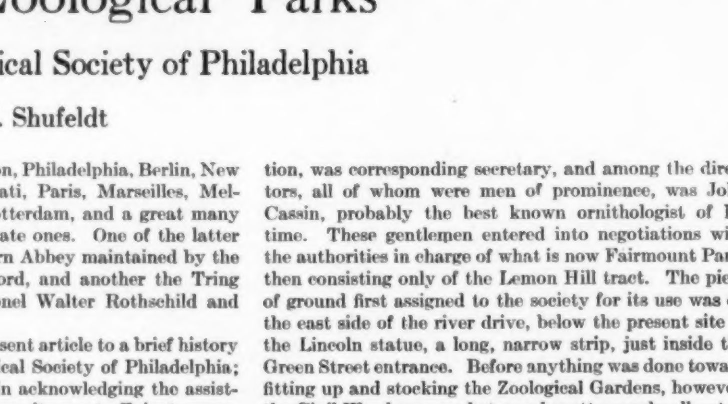
The first fruit of this movement was the procuring of a charter, which was dated March 21, 1859. The Zoological Society of Philadelphia was at once organized, and Dr. Camac was its first president. William R. Lejee and James C. Hand were vice-presidents; Dr. John Le Conte, one of the most distinguished naturalists of his generation, was corresponding secretary, and among the directors, all of whom were men of prominence, was John Cassin, probably the best known ornithologist of his time. These gentlemen entered into negotiations with the authorities in charge of what is now Fairmount Park, then consisting only of the Lemon Hill tract. The piece of ground first assigned to the society for its use was on the east side of the river drive, below the present site of the Lincoln statue, a long, narrow strip, just inside the Green Street entrance. Before anything was done toward fitting up and stocking the Zoological Gardens, however, the Civil War began and stopped pretty nearly all enterprises of that character. The project was at an end for the time being.

A few years after the war some of the same gentlemen who had before been interested in it came together and renewed the organization of the society, re-electing Dr. Camac president. The Fairmount Park Commissioners in 1873 granted the society part of the ground which its gardens now occupy, adding twelve acres, adjoining it on the east, in 1913, so that its present area is about forty-five acres.

After the ground was secured it was necessary to obtain funds to inclose, grade and drain it, to provide for a water supply, to lay out walks, erect shelters, inclosures, etc., and to cover the expense of getting together a sufficient number of wild specimens to make a creditable display. This was done by means of a loan of $320,000, which was subscribed to largely by public-spirited Philadelphians

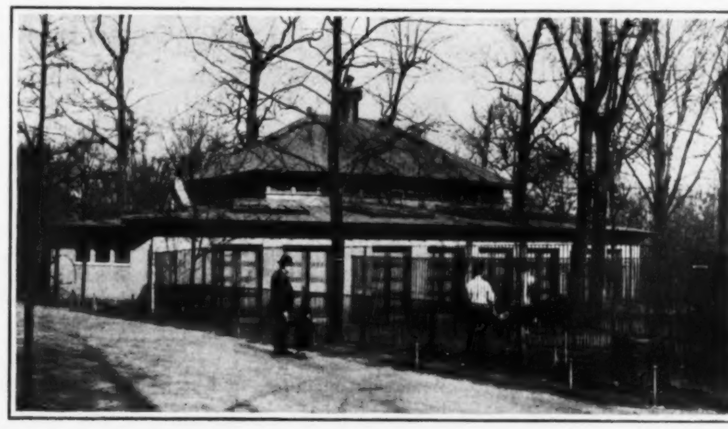


The monkey house in the Philadelphia Gardens.



Antelope house, with sea lion pool in foreground.

The ostrich house.



The reptile house.

who were interested in the project. Some years later the greater part of this loan was surrendered to the society.

The first definite object to obtain animals was the engagement by cable of Frank J. Thompson, an experienced collector, who was then in Australia. Thompson was a remarkable man and his personal history would fill a thrilling book. He camped at the falls of the Zambesi before Stanley was there, and he dug diamonds at Kimberley, South Africa, long before British capital had monopolized the mines. He procured wild animals in Australia, Africa and India, returning with them in the early part of 1874. The "Zoo" was then formally opened. The revenue for admissions from July 1, 1874, to February 28, 1875, a period of eight months, was $47,901; the next year the revenue was $87,984; in 1876, the year of the centennial exhibition, it was $151,060; since then it has ranged from $26,000 to $50,000.

The ground occupied by the garden is undulating, contains a stream of running water and a large artificial lake; the walks are of asphalt, and are shaded by many fine native and foreign trees.

Of the entrances, the most imposing one is at Girard Avenue, of which a beautiful view is presented. The main buildings are the carnivora house, the elephant house, and the antelope house, which were the first to be erected; an aviary, reptile house, ostrich house and house for small mammals; also a fine monkey house which was opened to the public in September, 1896, this taking the place of the original one which had proved inadequate. There are also many paddocks for bison, deer, camels, llamas, etc., pits and cages for bears, a series of pens for wolves and foxes, and pools for sea lions, otter and beaver, in addition to cages of special design for pumas, prairie dogs, skunks, etc.; there are also a raccoon and a porcupine tree.

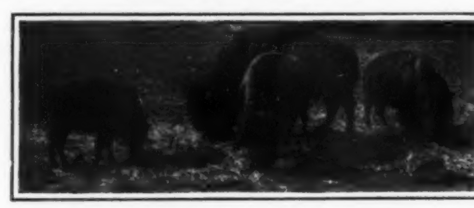
A feature of special interest is the outdoor monkey cage, tenanted by a group of macaque monkeys. Here, summer and winter, for several years, about fifteen of these animals have lived and thrived in perfect health and vigor, not one having died from the exposure. The monkey house is also provided with outside cages with doors communicating with the interior ones, and even in quite cold weather many of the animals are to be seen taking advantage of the open air. This, in connection with the comparatively low temperature of the interior, is believed to account for the general good health of the collection of monkeys, not one having died of tuberculosis, the scourge of the primates in captivity, during the past year.

Many other groups of mammals have been found to thrive better at much lower temperatures, during the cold season, than has been generally believed; among these may be mentioned the antelopes, including the giraffe, and the ostriches.

The society has for its object the making of a collection of living animals of the various known groups, which shall ever be representative of the world's fauna, rather than serial, by which is meant collecting large numbers of species more or less nearly allied to each other.

Among the mammals we usually find represented from ten to twelve of the generally recognized sixteen ordinal groups. These range from the lowly monotremata up to include the anthropoid apes, which are the largest of

Hippopotami in the Gardens.



American buffalo in the Gardens.

the primates, the group in which man himself belongs.

The affairs of the society are managed by a board of twenty directors, eighteen being elected by the members and loanholders, and two appointed by the city councils. An executive committee meets at the garden once a month, and it is through the initiative and activity of this committee that the many improvements and extensions of recent years are mainly due. The salaried positions are filled by a superintendent, a clerk, and the usual force of keepers, gardeners and gatemen.

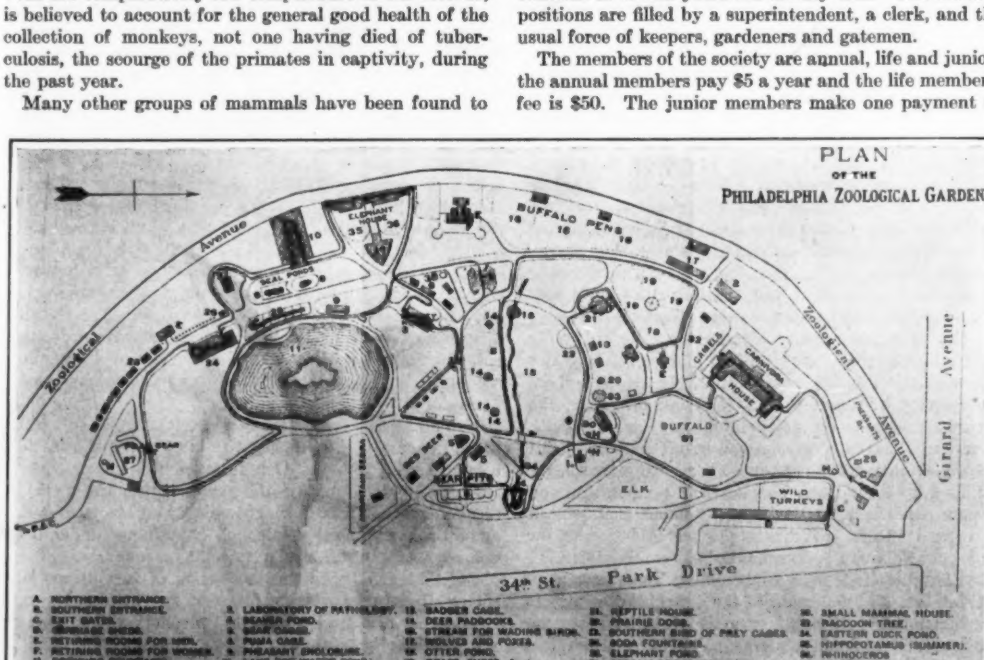
The members of the society are annual, life and junior; the annual members pay $5 a year and the life member's fee is $50. The junior members make one payment of $5, but their membership expires when they are eighteen years of age.

The garden is open every day in the week and the rates of admission are as follows: 25 cents for adults, and 10 cents for children between five and ten years old, except that on Saturdays and legal holidays the rates are 10 cents for adults and 5 cents for children.

For many years the society had to depend almost entirely on its gate receipts for the running expenses of the garden and for its permanent improvements, and it was not until 1891 that the society received any help from the city. In that year $2,000 was appropriated by the city council and this was increased in succeeding years. For the last three years $50,000 a year has been obtained from this source, in return for which 250,000 tickets are issued to the Board of Education, to be distributed among the pupils of the city's public schools.

One of the most attractive and beautiful features of these gardens is the lake. Here thrive a number of species of ducks, geese and swans, also mallards and teal, brant and Canada geese, American swan, the famous black swan of Australia, and a dozen or more other species.

Hundreds of animals of all kinds are received by these gardens every year. Some of the species are extremely rare, even in nature, while others are upon the verge of extermination. The Philadelphia gardens adopted the plan of the London "Zoo" in regard to visitors paying an admission fee, and in each case it has been the source of a large revenue, which may be applied to the various requirements in maintaining the garden. Then, too, the admission ticket is calculated to exclude many objectionable visitors, among them not a few who resort there for a number of purposes besides the ones for which the park is intended.



Cheap Subsitute for Horn

As a cheap substitute for horn the following composition is being employed. It is prepared from wheat flour and silicate of soda. The compound consists of mixing ten parts of silicate of soda with a little water, and then making an addition of fine wheat flour to the resultant liquid until a thick paste is formed with consistent stirring. This composition can be colored to imitate almost any kind of horn substance by mixing with the former ingredients different organic dyes to effect the object aimed at. The paste when mixed to the proper consistency is allowed to rest for some time to enable it to become hard, during which time the chemical reaction the mass undergoes causes the production of a horn-like substance so hard and strong that it may be turned and machined like brass or other metal. When the composition is first made it may be molded without pressure into any desired form, and thus in many ways it may be employed to replace real horn. —*The American Jeweler.*

Germany Devises Substitutes

To economize in copper Germany has devised an alloy consisting of soft iron having small additions of copper and zinc, and treated by a special process, which takes the place of copper and brass in cartridge cases both for large guns and rifles, fuse-heads for shells and grenades and many similar purposes. To meet the shortage of aluminium, a process has been devised for recovering the aluminium from ordinary clay containing 30 per cent Al_2O_3, which also provides for the simultaneous extraction of the alkalis, particularly potash. Two factories for working this process are being completed, and it is expected that they will make Germany independent as to her future supplies of aluminium. It has been shown that metallic magnesium, and particularly a magnesium-aluminium alloy, may possibly replace copper as an electrical conductor. A large plant is, it is said, being erected to use the magnesium chloride which is a by-product of the potash industry.

The Hardwood Distillation Industry*

And What the Chemist Has Done For It

By S. W. Katzenstein

THE hardwood distillation industry has been brought to popular attention of late, on account of the rapid increase in value of one of its products, acetate of lime, which is being converted, in large amounts, into acetone for the manufacture of smokeless powder. This recent impetus has been a great boon to the industry, for with low prices for wood alcohol since the passage of the denatured alcohol act, overproduction and low prices for acetate of lime and a constantly decreasing premium for charcoal pig iron, the outlook for the industry has not been brilliant for the past few years.

It was the last named condition which made the advent of the chemist into the wood distillation industry imperative. Necessity called him in to show how efficiency of operation, with low prices, might replace obsolete processes, stimulated by high prices. He came into the industry as efficiency engineer.

It has been in the treatment of the crude pyroligneous acid resulting from the wood distillation and in the recovery and refining of the valuable products that the contribution of the chemist has been of greatest value. Although he has shown the importance of temperature control of carbonization; of the physical condition of the wood; of the proper condensation and scrubbing of the non-condensable gases; although he proved beyond question the necessity of the abandonment of the old kiln process and the adoption of the more efficient oven or retort system; yet it has been in the treatment of the products of wood distillation that he has served the industry most usefully.

To outline this treatment of the pyroligneous acid, we have the following steps, after the settling of the crude liquor for the purpose of removing the insoluble wood tar:

1. Distillation of the crude acid liquor for the purpose of removing the tar in solution.
2. After neutralization of the crude acid liquor by means of milk of lime, separation of the volatile products, viz., methyl alcohol and acetone, from the acetate of lime of the neutralized liquor.
3. Concentration and drying of the acetate of lime.
4. Concentration and refining of the wood alcohol.

The primary distillation of the crude liquor was usually a simple distillation under atmospheric pressure, carried out in copper stills, fitted with cylindrical steam coil, copper goose and vertical tubular condenser. The operation consisted of feeding the crude liquor into this still continuously, while the process of distillation was carried out by means of live steam in the coil. This was continued ordinarily for three days, when the addition of crude liquor was stopped and the distillation continued until no further product was obtained. Then live steam was entered in the still and a further amount of distillate containing a large percentage of acetic acid was obtained. The matter of keeping the coils of these stills free from tar and carbon deposit was a difficult one, especially where the liquor was obtained from the kiln process. For the retort plant, it was necessary only once a week to enter a charge of settled tar which, in this process, contains a large amount of oils.

The crude liquor generally entered these primary stills at the temperature at which it was obtained from the retort or kiln condenser. Seldom were preheaters, operated either by the use of the steam condensate from the coil or the heat in the distilling vapor, used. When it is remembered that substantially 90 per cent of the crude liquor is distilled, it will be readily seen that the process was a very costly one, not only on account of the high steam consumption, but also on account of the large investment in copper stills, coils and necks, all of which required frequent renewal.

The separation of the volatile constituents, viz., methyl alcohol, acetone and methyl acetate, from the acetate of lime of the neutralized liquor was carried out by a simple distillation in the so-called "Lime-Lees" stills—vertical iron tanks, fitted with copper coil on the bottom, with a vertical goose, consisting of an iron pipe of varying heights, leading to a surface condenser, similar in construction to that used in the primary stills. The operation of these stills consisted of alternately filling the still with the neutralized liquor and, by means of live steam in the coil, distilling the volatile constituents until the watery distillate showed, by hydrometer test, no further alcohol content. According to the nature of the liquor, that is, if from retort or kiln and also depending on the nature of the goose, the distillate obtained in this process would vary from 5 to as high as 50 per cent alcohol.

The weak acetate of lime solution remaining in the Lime-Lees stills was then pumped or drawn into storage tanks, settled and fed to open, double bottom graining pans. The solution was evaporated down and grained, with the necessary stirring or "spudding" to secure proper grain of the final product. The final drying of the acetate of lime was then carried out, either on the brick tops of the retort setting by means of the waste heat from the retort, or on an iron dry floor, set on brick flues and heated at one end by coal fire, or by means of waste boiler gases. This process required a large amount of labor in the graining and raking of the drying acetate on the floor.

The watery alcohol distillate from the Lime-Lees stills was generally concentrated in intermittent stills, consisting of an iron still, fitted with scroll coil, the vapors passing through copper columns of various design, frequently built with perforated plates and return pipes, with tubular separator and condenser at the top for increasing the proof of the distillate by means of fractional condensation. Frequently, the refining distillations are carried out in columns built of plates, with a large number of boiling pipes and caps for the purpose of better separating the more volatile acetone from the methyl alcohol.

The process indicated above involved, in some plants, as many as seven separate distillations from the pyroligneous acid to the refined alcohol; and, where carried out with live steam under atmospheric pressure, it resulted, of course, in great fuel consumption and excessive amounts of water required for condensing and cooling purposes. To these may be added the constant loss of products, due to the rehandling of the volatile material, especially when it is remembered that, even in the northerly plants, the available water frequently rises in temperature in the summer months to a point at which losses of volatile material may be considerable. The improvements undertaken, therefore, in the last few years have had these objects in view:

1. Economy of steam in evaporation and distillation.
2. Economy of water for condensing and cooling.
3. Greater simplicity of operation, involving the elimination of repeated condensations and consequent re-distillations in the step-up process.

The greatest steam consumer was the first step in the process, the distillation of the acid for the removal of the tar in solution. The first departure, therefore, from the atmospheric evaporation was the introduction of vacuum evaporators. With the recognized advantage of single or multiple-effect evaporation, the introduction into this industry was long delayed for various reasons. In many plants which operated in connection with sawmills, refuse has been sold to the chemical plant at a round figure, generally quite favorable to the chemical plant. With the large excess of waste available, the necessity of steam economy was, therefore, not present at these plants, and it was at the plants without this favorable connection or at which the utilization of lumber was closer, that the introduction was first made.

The nature of the problem involving the evaporation of a liquid containing volatile products (methyl alcohol and acetone) together with an acid (acetic) with a tarry residue, in solution and held colloidally, presented many new conditions for the builder of evaporators. Generally, their work had involved the concentration of a dilute aqueous solution, in which case the removal of the distillate at a high temperature was permissible. With pyroligneous acid, however, the presence of methyl alcohol and acetone necessitates the use of very efficient condensing and cooling apparatus to prevent losses of these valuable products. Again, the tar in solution presents a substance which rapidly forms a coating on the evaporator tubes, quickly reducing the heat transference and decreasing the boiling and circulation in the evaporator. The following conditions were essential, therefore:

1. Complete accessibility of all evaporator tubes for cleaning, inside and out. The cleaning problem varies with the nature of the crude liquor, that is, if derived from retort or kiln process; and the matter of keeping the evaporator clean is the most serious problem met with in the use of the vacuum evaporator. It is at this point that the attention of the chemist is most necessary, for it is his duty to indicate, judging from temperature and pressure conditions, in the different vapor chambers of the several effects, just where the accumulation of tar has brought about the decrease in heat conductivity.

2. Efficient condensing and cooling apparatus is of vital importance on account of the difficulty of complete condensation, while working under the high vacuum. The design of the condensing apparatus, therefore, in this case, should take into consideration a considerable length of path for vapors and gases before the non-condensable gas is allowed to escape from the apparatus.

3. The prevention of entrainment is important on account of the possible contamination of the distillate by a small amount of tar which might be thrown over and which causes difficulty in the later drying of the acetate of lime solution. Hoods, built within the evaporator body itself, where the evaporator tubes are vertical, have lately been found to be of great advantage in this regard and permit rapid circulation in the boiling chamber, without fear of entrainment.

Again, in the concentration of the dilute acetate of lime liquor, the introduction of the vacuum evaporator has brought about great savings in steam and consequent lowering of costs. Here, also, the possibility of losses by entrainment was present, but has been completely eliminated by the use of horizontal tubes in the construction of the evaporator. The particular type of evaporator introduced has depended upon the saving to be brought about, in other words, upon the availability of exhaust steam or sawmill refuse. Hence, the single or double-effect evaporator would be introduced where considerable exhaust steam was available or where fuel was cheap, while the triple-effect would find its place where coal at a high price was used for fuel. Combination evaporators have been introduced with success in several plants. Thus, a common type is a double-effect evaporator, the first effect of which is an iron pan, equipped with horizontal tubes, serving to concentrate the acetate of lime solution, while the second effect, operated by the vapors from the acetate pan, is a copper pan with steam chest equipped with vertical tubes for the distillation of the pyroligneous acid. Further economy has been secured by the introduction of preheaters for the crude liquors, which use the various waste condensates as the heating medium.

The final drying of the concentrated acetate of lime solution from the evaporators is now carried out very efficiently by means of mechanical driers which have eliminated the high labor costs of the old dry floor process. Rotary cylindrical driers, operated with steam within the cylinder, with the concentrated solution without, and fitted with scrapers to remove the acetate mud, have been eminently successful, the final drying taking place on horizontally moving canvas belts traveling over a series of pipes heated by exhaust steam or, better, the wet material is fed into a continuous wire belt moving vertically counter to a current of waste gases from blast furnace stoves, or boilers, reduced to the proper temperatures for drying. The latter arrangement produces a uniform product, especially free from dust, with one quarter the labor previously used on dry floors and with a considerable saving of steam.

Returning to the second step of our process, the separation of the volatile components from the acetate of lime solution, we find that the introduction of continuous columns has halved the amount the steam formerly used in the old Lime-Lees and the distillate is brought to high proof in one operation, thereby eliminating the step-up process of intermittent distillation. These continuous columns are of various types, frequently of plates equipped with boiling pipes and caps, the preheated neutralized liquor entering at the middle part of the column, the lower half then serving to deprive the neutralized liquor of the volatile products, the upper half concentrating the volatile distillate continuously. An improved arrangement which has been put in successful operation during the last few weeks consists of two separate columns, the first one serving only to remove the alcohol from the neutralized liquor and discharging a low-proof vapor into the middle of the second column, which operating on this vapor produces a high-proof distillate, miscible with water, while discharging waste oils and watery condensate from its base. This latter arrangement is a considerable improvement over previous columns in that this latter discharge will not dilute and contaminate the acetate solution, as has been the case heretofore.

In refining the crude wood alcohol, continuous columns have, in some plants, replaced the intermittent stills to a considerable extent. Columns are now in successful operation which separate the acetone from the methyl alcohol, so that a 50 per cent solution of acetone and, simultaneously, methyl alcohol containing under 0.1 per cent of acetone, are obtained continuously. The chemist's ingenuity in the production of various special solvents and mixtures has been of great value in the creation of new uses for methyl alcohol, which to-day are of great importance in disposing of the product, when the market for the regular grades is poor.

It is not within the scope of this paper to mention the

* *The Journal of Industrial and Chemical Engineering.*

work that has been done in the further development of wood distillation products, namely, the manufacture of acetone and acetic acid from acetate of lime; of formaldehyde from methyl alcohol and of wood creosote from wood tar. We need only mention that these are purely chemical developments and their increasing importance to-day is a tribute to the American chemist.

Thus the work of the chemist is apparent at every important step of the hardwood distillation industry and it may safely be said that the introduction of the improved apparatus described and its successful operation would never have been accomplished without the guidance of the chemist.

The Electrical Universe

By Our Berlin Correspondent

It is a remarkable fact that, in performing her annual revolution round the sun, our earth, in spite of multitudinous disturbances, should never reach her journey's end even a minute behind or in advance of her time. This is the more surprising as the disturbances in question—accelerations and retardations due to the variable constellations of planets and the interference of comets—are absolutely different from one year to another. That these irregular influences should automatically compensate one another, seems no more possible than that an electric train having lost its driver should, of its own accord, control its speed of traveling.

In an unusually suggestive article published in *Der Zeitgeist*, Georg Korf draws attention to this phenomenon which is not always duly appreciated. Still, the great astronomer Herschel already realized that, in addition to mass, force and speed, there must be other factors at work in the universe. A will, he said, was required to impart a circular motion, and another will to arrest it. This accounts for the fact that a planet retarded in its motion is "clever" enough to calculate exactly its time so as to arrive at the appointed minute.

According to the theosophical views expressed by Dr. F. Hartmann, in place of a "medley of unconscious mechanical forces, there would be a world of life, consciousness and intelligence." Every being would at bottom be a psychical entity constituting some condition of God's All-consciousness in Nature; every being would have a soul of its own, that is, a life moving between certain limits, its physical appearance being but an outward corporeal image of its qualities in the visible world. Each solar system, each star, each creature, down to the atom, would thus be a being of its own, having some sort of individuality, some individual consciousness, which of course was quite different from our own consciousness and inaccessible to human conception.

According to these views, the earth, sun and stars would resemble animated beings rather than driverless locomotives of the cosmos. The same as there is above the driver and above the electric motor the constructor, and above him the inventor who assigned its functions to the wisely generated and controlled electric force, a long time before that special apparatus and its present driver were in existence, our reason must presuppose a maker and conductor of the earth and stars and a designer of their forces and trajectories.

Some interesting suggestions of the same kind are found in a recent book by G. W. Surya, "Occult Astrophysics," with the sub-title, "Is science able to account for the motions of stars?" (Max Altmann, Leipzig, publishers) some of the leading ideas of which are resumed in the following:

The various planets have been likened to the more important organs of the human body, the sun being, e. g., the heart of our solar system. A parallel conception in the microcosmos Man would be that the ganglions are brains in miniature of the various organs, animated by some life-giving principle independent of man. Heart beats, digestion and respiration thus go on during sleep, independently of our waking consciousness, which does not exclude the possibility of their being influenced.

Another interesting consideration is the following: "If scientists have so far found nature to work everywhere in accordance with the principle of minimum expenditure of energy and matter, why should not this mode of most convenient power transmission have been realized in the universe, ever since the beginning of creation? Why should nature be economical only in connection with creation on a small scale, while being lavish in her greater works? Would not this be something of the same sort as the inapplicability to cosmical conditions of some fact observed on a small scale, e. g., the law of levers or the 47th proposition of the first book of Euclid? Is such a contradiction conceivable?"

However, in the case of cosmical power transmission science taxes nature with excessive prodigality, the earth receiving, for instance, only the 2170 millionth part of solar radiation, the remainder—apart from the likewise negligible portion benefiting the rest of the planets—being sent out to no useful purpose into the cold cosmic space. According to our superficial knowledge, this would indeed appear quite correct, but the suggestion is here made that in an animated universe peopled by animated and intelligent beings, the concentration of energy radiation in certain directions, as attempted and partly realized by radio-telegraphy, has long been conceived and achieved by cosmical beings. If so, all the energy radiation leaving the sun would reach the planets, nothing being lost in space, intense energy currents flowing between the sun and his planets, similar to the currents between the ganglion knots and the central nervous system in the human organism.

According to a modern conception, the sun would be a gigantic dynamo, the energy oscillations of which, in a form neither hot nor luminescent, arrive at some smaller dynamos or electric motors (planets), in order there, for the sake of consumption, to be converted into such forms of oscillations—light, heat, magnetism, etc.—as are required for consumption.

The same conception has also been suggested by modern astronomers. Dr. Archenhold, director of the Treptow, near Berlin, Observatory, in a memoir published in 1909 (see *Die Woche*, No. 40, 1909), on "Sun Spots, Aurora Borealis, and Currents of Terrestrial Magnetism," suggested the idea that the sun sends to the earth electric currents due to the sun spots, the sun being comparable to a transmitting station in wireless telegraphy, and the earth being the receiving station. The earth's crust being made up of the most various substances, which are alternately good and bad conductors of electricity, the electro-magnetic currents coming from the sun would meet with resistances bound to generate considerable amounts of heat.

According to Lord Kelvin, the sun, during a magnetic disturbance lasting only eight hours, would radiate as much energy in the form of electro-magnetic waves as the amount normally received during 120 days in the form of light and heat. Such an increase in the electrification of the earth is understood by a "magnetic storm."

Though only a small part of the actual amount of energy received from the sun be converted into heat, this suffices to produce the most gigantic effects, causing extinct volcanoes to begin working again, developing steam of enormous tension in underground water sheets, and thus accounting for the fact that volcanoes, at a time of increased sun activity, will pour out lava, the earth's crust be shaken by earthquake tremors, due to the increase in pressure of the inclosed vapors, etc.

We are thus exposed to the enormous electro-magnetic forces of the sun. According to Hales' observations, the intensity of the magnetic field with sun spots would be 10,000 times as great as the directive force exerted by terrestrial magnetism on a freely moving magnetic needle.

Since electro-magnetic oscillations of considerable intensity are bound to precede an earthquake caused by such disturbances, they are bound to make themselves felt in some way or other before the outbreak of seismic activity. Supposing the nervous systems of certain genera as well as that of especially susceptible persons to be sensitive enough directly to perceive the current fluctuations produced by the sun, there would be nothing strange in animals in great crowds hastening to leave the endangered district even 24 hours before the outbreak of a serious earthquake catastrophe, as has been the case at Martinique and Messina. If we were able to recognize beforehand the causes of increased sun activity, which in accordance with the views here expressed could be calculated from the constellations of stars, it would be possible to predict earthquake catastrophies some considerable time in advance. This had been attempted by August Zoppritz, who in his "Prognoses from Star Constellations for the Years 1908 and 1909" predicted earthquakes on a large scale for December, 1908. Messina unfortunately justified only too well his conclusions.

If the sun and planets are enormous electric central stations, comparable to dynamos, influencing one another by current fluctuations, astrology of old would again become suitable for scientific discussion. There would, in fact, be nothing wonderful in the earth and her human beings "feeling" in some way or other the current fluctuations in question, the psychical emotions thus produced being dependent on the special planetary cause. The electric or radio-active influences due to each planet could thus very well be of a specific nature.

Inasmuch as a mutual effect between the earth and planets must be assumed, there would also be a possibility of the thought oscillations of men influencing the electro-magnetic oscillations of our whole solar system, which in their turn would react on the minds of mankind. This would thus become an important determining factor in human fate.

The Cause and Cure of Pellagra

Announcement was made at the Treasury Department recently that as a result of continued research and experiments of the Public Health Service, both the cause and the cure of pellagra have been discovered, and that the spread of this dread malady, which has been increasing in the United States at a terrific rate during the past few years, may now be checked and eventually eradicated.

Pellagra has been increasing alarmingly throughout the United States during the last eight years, and it is estimated that 75,000 cases of the disease will have occurred in the United States in 1915, and of this number at least 7,500 will die by the end of the year.

The final epoch-making experiment of the Public Health Service was carried out at the farm of the Mississippi State Penitentiary about eight miles east of Jackson, Miss., and together with the previous work of the service completes the chain in the prevention and cure of the disease. The work at the Mississippi farm has been in charge of Surgeon Joseph Goldberger and Assistant Surgeon G. A. Wheeler of the United States Public Health Service. The farm consists of 3,200 acres, in the center of which is the convict camp. The final experiment was undertaken for the purpose of testing the possibility of producing pellagra in healthy human white adult males by a restricted, one-sided, mainly carbo-hydrate (cereal) diet. Of eleven convicts who volunteered for this experiment, six developed a typical dermatitis and mild nervous gastro-intestinal symptoms. Experts declare that the disease which was produced was true pellagra.

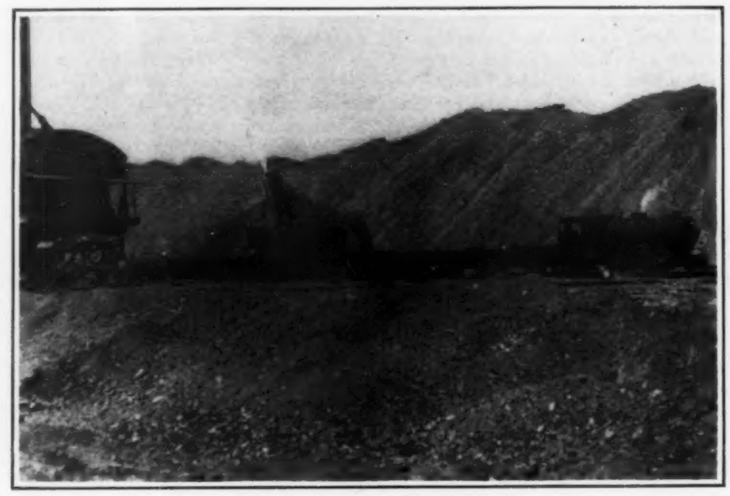
Prior to the commencement of these experiments no history could be found of the occurrence of pellagra on the penitentiary farm. On this farm are 75 or 80 convicts. Governor Earl Brewer offered to pardon twelve of the convicts who would volunteer for the experiment. They were assured that they would receive proper care throughout the experiment, and treatment should it be necessary. The diet given was bountiful and more than sufficient to sustain life. It differed from that given the other convicts merely in the absence of meats, milk, eggs, beans, peas, and similar proteid foods. In every other particular the convicts selected for the experiment were treated exactly as were the remaining convicts. They had the same routine work and discipline, the same periods of recreation and the same water to drink. Their quarters were better than those of the other convicts. The diet given them consisted of biscuits, fried mush, grits and brown gravy, syrup, corn bread, cabbage, sweet potatoes, rice, collards and coffee with sugar. All components of the dietary were of the best quality and were properly cooked. As a preliminary, and to determine if the convicts were afflicted with any other disease, they were kept under observation from February 4th to April 19th, two and a half months, on which date the one sided diet was begun.

Although the occurrence of the nervous symptoms and gastro-intestinal disturbances was noted early, it was not until September 12th, or about five months after the beginning of the restricted diet, that the skin symptoms so characteristic of pellagra began to develop. These symptoms are considered as typical, every precaution being taken to make sure that they were not caused by any other disease. The convicts upon whom the experiment was being made, as well as twenty other convicts who were selected as controls, were kept under continuous medical surveillance. No cases of pellagra developed in camp excepting among those men who were on the restricted diet.

Action of Acetylene on Metals

Results from a series of experiments to ascertain the effect of acetylene on metals appear in a recent issue of *Chem. Zeit.* Specimens of various metals and alloys, in solid, powder and foil forms, were exposed for twenty months to the action of acetylene in three groups. In the first group acetylene from a generator, collected over brine, was passed slowly over the metals being examined: in the second group the gas was purified by being passed through solutions of salts of lead, copper and iron, and through glycerine; in the third group the gas was thoroughly dried by soda lime and calcium chloride. The dry gas of the third group did not attack any of the metals tried. The purified, moist gas of group two was also fairly inert, as it attacked only nickel and copper, which increased in weight respectively 1 and 1.6 per cent. The crude, moist gas of the first group gave entirely different results, as zinc, lead, brass, and nickel showed an increase in weight of about 1 per cent; iron, 6.5 per cent; phosphor bronze, 15 per cent. Copper suffered most, as it increased in weight from 80 to 90 per cent, and was converted into a soft black mass, which, however, did not contain any acetylene. The increase in weight was due to the deposition of carbon and the absorption of water. This indicates that to protect copper and copper alloys from acetylene these metals should be coated with tin rather than nickel. In this group tin, German silver, solder (composed of tin, lead and traces of copper) and aluminium bronze (Al, 92 per cent; Sb, 2.6 per cent; Cu, 5 per cent) were almost unaffected.

Grant stripping shovel with 90-foot handle.



Scooping out the coal with small shovels.

A New Method of Mining Coal

Open Mining Made Possible by Giant Shovels

By John Timmons

To avoid labor troubles and to secure the entire product in mining coal, has brought about very interesting conditions in two or three counties in eastern Ohio, where coal is being mined in a new and novel manner, which promises to create conditions which may be the cause of the Federal Government interfering to such an extent that the scheme which now looks so good may fail utterly.

The coal in many parts of eastern Ohio is not covered with as much earth and rock as in other parts of the country, and very frequently there is less than 50 feet of earth above what is known as the Pittsburgh No. 8 vein.

The new method of mining is to strip the land by means of huge steam shovels, which are greater than any used in the construction of the Panama canal. These huge steam giants remove the earth, shale and rock which cover the vein of coal, and smaller steam shovels follow up and lift the coal into cars which are run in to the edge of the coal, and these are run off to a tipple where they are loaded into regular coal trains.

The large steam shovels are placed on great double tracks and are propelled by their own power. The machine base is 20 by 52 feet, and it weighs over 300 tons.

There is a boom 90 feet in length, which alone weighs 40 tons, and this boom controls the 90 foot handle to a huge dipper, which can remove from two to three wagon loads of dirt and rock at each movement.

The scoop commences at the bottom just above the coal, and tears its way upward through from 10 to 50 feet of shale and rock, as the location may be, and the boom swings to either side and deposits the refuse in ridges, which are about 180 feet apart when the coal has been removed.

The great machine moves in circles, piling the earth in heaps where the coal has been taken out, and the land which has undergone the ordeal of being completely transformed, has the appearance of the northwestern bad lands. Some say it will be as useless and barren for all time to come.

The huge steam shovel is followed up closely by smaller steam shovels, which rapidly remove the entire coal product.

It requires three shifts of 14 men each to run the new method of mining, and the men average about 42 tons each; while in the old way of mining coal, men seldom exceed 7 tons, and the average is near 5 tons each.

With the old underground method only from 64 to 70 per cent of the coal is removed, owing to so much having to be left to support the hill overhead, while in this new manner of mining all the coal is taken out, and several by-products are secured. In some locations limestone, which is worth 75 cents a ton crude and $2 a ton when crushed, is found above the coal, and in some places sulphur balls, which are used in dye works, are found and are worth separating from the other materials.

It is said the land is practically worthless after the new mining process, and farms which are being sold, and upon which this new industry is being operated, which have been the finest fertile lands, producing the best of crops, are apt to be a barren waste, not worth the taxes assessed.

The companies purchase the land outright, and it is said these corporations will not pay the taxes after the coal is removed. The Federal authorities are being asked to interfere, as it is claimed such wastes will interfere greatly with lands adjoining, which were not sold for mining purposes.

Some are advancing the theory that if laws were enacted compelling those mining the coal to leave the land comparatively level, in a short time alfalfa or timber could be grown and in time the land would be reclaimed and be as valuable for some kinds of farming as it formerly was.

As much as three fourths of an entire township of the finest farming lands, with several small villages, has been purchased by one of the companies, and much land in other sections. Hundreds of people are visiting the scene of this new mining and it is arousing great interest.

If the new method proves to be a success here, several large companies are expecting to try the plan in other localities, and in time deserts will appear throughout our beautiful country and people will have to seek homes elsewhere. It is said the prices paid enable the farmers to go to other sections and purchase much finer lands and have money left to improve them.

Genus Allium

Antiquity and Utility

Perhaps it is advisable to explain at once that allium is the family name of the onion and kindred vegetables. Strict botanists may object to that homely method of stating the case. They would say that the genus allium consisted of bulbous plants of the lily family, and would surely refer to hexandrous flowers and other characteristics which do not concern ordinary people, whose chief consideration is the domestic cuisine and economy therein. Among the most important members of the group are the onion, the leek, the shallot, the chive, rocambole, and garlic.

Although the stress of war time has done much to foster simple tastes in the matter of food, there are still many to whom the mention of an onion is suggestive of vulgarity. The useful vegetable is spoken of almost derisively. It is time that such ideas were done away with once and for all. In reality the onion is classic fare. Homer refers to garlic as being served up by Nestor to his guest Machaon. The Israelites in the wilderness longed for the onion, and bemoaned its loss to Moses. The greatest epicures and the most successful chefs have always described it as the basis of cookery. Dean Swift declared it to be every cook's opinion that "no savory dish without an onion."

To be thoroughly practical the time is opportune for the free use of onions, which are plentiful and cheap. Throughout the winter and spring the British populace, like the Israelites of old, complained of the scarcity of onions; and not without reason, because supplies were short, and prices ruled abnormally high. Now that stocks are abundant, and onions are obtainable everywhere at one penny per pound, the public are inclined to ignore the utility of the vegetable.

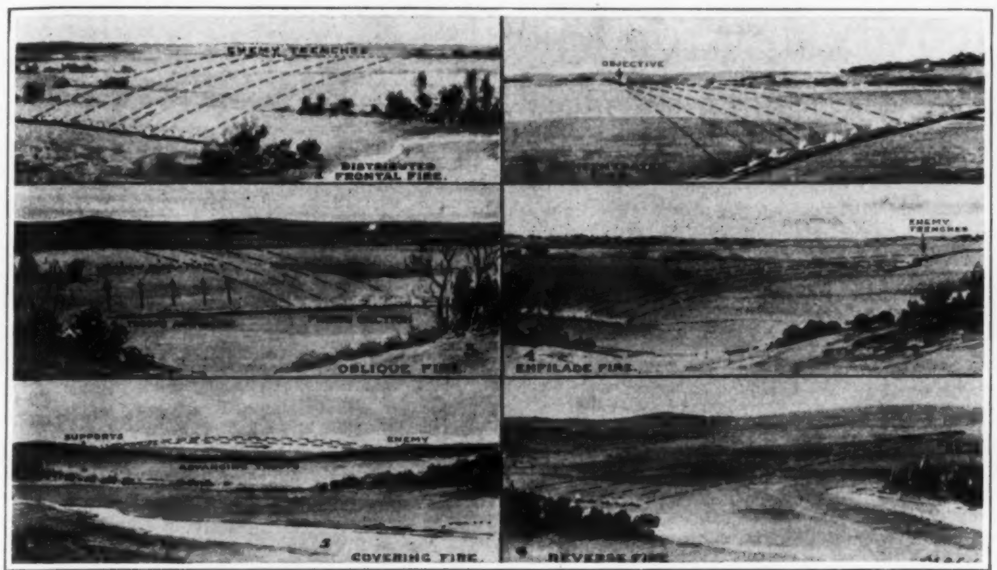
Although the last of the season's shipments from Egypt has arrived, there are plenty of good and sound onions stored in warehouses. Naturally, there is a proportion of inferior stuff, but that need not trouble the housewife, who will not experience the slightest difficulty in buying onions of edible quality. The Egyptian onion is that which attracted the attention of the famous Swedish traveler, Hasselquist, who declared it to be the most savory variety he had ever tasted. That, however, was some time ago—in the middle of the eighteenth century, to be precise.

Specially worthy of notice at the moment are the brown onions of the Canary Isles. These are not favored by the public because of their being somewhat unsightly. It is more than curious how this question of appearances should affect the sale of an article such as the onion. That choice dessert fruits like peaches and grapes are valued to a great extent by their appeal to the eye is comprehensible enough, but onions surely may be allowed the privilege of being ugly without depreciation. The brown Canary onions now on the market are tender, mildly flavored, and excellent from a culinary standpoint, yet consumers do not appreciate their merits because they are not the most attractive in shape and general appearance. While other kinds were scarce, Canary onions sold freely. That is but one of the many vegetarian eccentricities of this country. Another is the habit of sending washed carrots and turnips to market. When so treated both lose much of their flavor; furthermore, they do not keep so well as when the earth is allowed to remain on them. The premature washing of vegetables leads to waste; why, then, should not this simple process be done in the home? Perhaps it is too laborious.

Spanish onions are not at their best just now. Not until the winter does Valencia send its best ripe specimens. Those arriving at present cannot be described as more than moderately good. Nevertheless, they are a useful addition to insipid viands.

Garlic is too strong for the majority of tastes, and should always be used sparingly. The leek, when in season, is one of the most acceptable members of the genus allium. It is supposed by some authorities to be a native of Switzerland, but it is probably of Eastern origin. Welshmen wore the leek by order of St. David that they might be distinguished in the battle when they conquered the Saxons in the sixth century. The shallot—a native of Palestine—comes between garlic and the onion in point of strength and pungency. Chives, though seldom used in England, are much in vogue in Scotland.

Onions contain a volatile oil in greater degree than any other of the species allium. This oil is dispersed by boiling. Many who cannot assimilate onions fried or roasted can eat them when boiled without experiencing digestive trouble. This principle can be applied to stews. When there is any doubt about digestibility, the onions should first be scalded for twenty minutes. Onions scalded save the cook from being scolded.—*The London Daily Telegraph.*



Cuts by courtesy of *The Illustrated War News*

The normal methods of rifle-fire employed in the attack and defense of positions and in the open.

According to the official "Infantry Training Manual," from 1,400 to 2,000 yards may be taken as the average "long-range" firing distance in action under ordinary circumstances for troops firing at a large or clearly defined target, such as that offered by an enemy force in mass or column formation. Between 600 and 1,400 yards is generally held to be a specially dangerous zone for troops exposed to collective fire. Within 600 yards individual aiming comes more actively into play with effect. The Lee-Enfield is sighted for every 25 yards from 200 to 2,800. The extreme distance to which it can carry is about 3,500 yards, or two miles. For ammunition supply each man carries 150 rounds, and the regimental reserve and main ammunition columns within close touch with the battle-front carry 300 more rounds per man.

Rifle Fire

How It is Employed in Attack and Defense

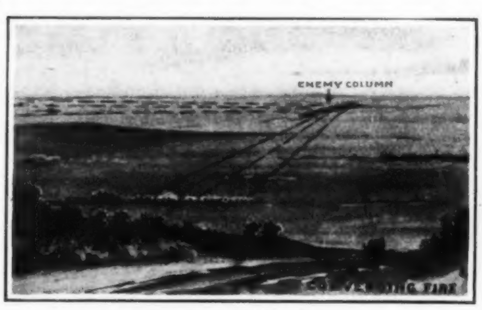
The rifle is to-day, as it and its earlier equivalent the musket have long been, the infantryman's principal weapon. Although its work, under certain conditions, can be more effectively done by the machine-gun, the weight of the latter and the enormous amount of ammunition it requires prevent it from displacing the older type of firearm.

The independent fire of a skilful marksman, acting as a "sniper," is calculated to cause loss and discomfort in the enemy's trenches, and to discourage his attempts at observation; but the concentrated and organized fire of a body of men is needed—is, indeed, indispensable—for stopping an enemy's charge or in preparing for an advance. Organized rifle-fire is applicable in various ways, the particular method adopted depending on the circumstances of each individual case. An advancing body of men whose front is about equal in length to that of the trench to be attacked is dealt with by "distributed frontal fire" (Fig. 1). Each man in the trench fires at the point in the advancing line which corresponds to his own position in the trench.

At times it may be necessary for riflemen to dislodge a number of snipers from light cover, or to put out of action a machine-gun. In this case the system known as "concentrated fire" (Fig. 2) is employed, all the men firing at the same spot until their object is effected.

"Oblique fire" (Fig. 3) is used by the men in one portion of a trench in order to keep down the fire from the enemy's trench while it is being advanced against by their comrades immediately facing the point attacked.

Then we have another point to be noted. While the fire applications just mentioned are eminently useful in preparing for or checking an assault, they alone, without the subsequent bayonet-charge, cannot be relied upon for actually enforcing the evacuation of a trench, unless it is possible to place the attacking force in such a position as to "enfilade" (Fig. 4), the trench, or, in other words, to fire down it lengthways from the flank. This, fortunately, can sometimes be done. If circumstances permit of the concealment of a body of men until the enemy's line has passed their position, so as to enable them to fire on the enemy's rear, a very useful moral effect is produced. In such a case the fire, coming from an unexpected quarter, cannot be easily dealt with. Such method is known as "reverse fire" (Fig. 6). Where troops, held in reserve as supports, are situated on high ground, they may keep up a "covering fire" (Fig. 5) on the enemy's trench over the heads of their comrades in front, while these are advancing over the intervening lower ground to the attack. The effect of this covering fire reduces the losses sustained by the advancing men in that it harasses and prevents the enemy from using his rifles and his machine-guns to full advantage. Careful calculation and good judgment as to the correct moment for opening fire are very necessary on the part of the officer responsible. A premature outburst of firing on his part may enable the enemy to locate the position and learn approximately the strength of the opposing force while the range is yet too long to obtain results sufficiently marked to discount the disadvantage. On the other hand, if the fire be withheld too long, the enemy will be at close quarters before his numbers have been reduced to manageable proportions, to an extent that an earlier opening of fire would have made possible. Charging troops should not, as a rule, open fire until they are fairly close to the enemy's trenches. They will require most of their supply of ammunition for the final effort. When the advance is made over a long distance, with the help of cover at intervals, this rule does not apply, as fresh supplies can then be brought up before the final rush takes place.—*The Illustrated War News.*



Converging fire directed from two points: A column attacked at long range while in march formation.

Converging fire is a concentration of projectiles aimed from different quarters, fire directed on the target from more than one firing point. In the foregoing illustration, bullets from men drawn up on an extended front converge on the narrower space offered by a column nearly end-on to the firers. The firing is simultaneous, and, according to the angle of aim, may be frontal, oblique, enfilade, etc.

Artificial Rain*

By Prof. Dr. E. Kruger

In this journal for June 20th there was a complaint general both in city and country, about the prevailing and unexampled drought which bids fair to put even the famous draught of 1911 in the shade. It calls upon German inventiveness to furnish help, and even makes some suggestions of its own, proposing that the county watering-carts and fire-engines be charged with distributing water about the fields. This procedure might, indeed, suffice to supply a city garden with water, but it is not competent to bring any relief to our fields. This becomes evident at once when it is remembered that 10 cubic meters of water are required to cover one hectare to a depth of only 1 millimeter, while a hectare in growing cereals consumes over 100 cubic meters of water daily by evaporation. Since a county water wagon rarely has a capacity of as much as 1 cubic meter, who is going to supply the train of innumerable water carriers necessary to serve a field of only moderate size? Besides, there are many agricultural and purely technical considerations that oppose this well-meant suggestion.

However, the "German inventiveness" appealed to has already bestirred itself in this direction, and has provided a method for furnishing refreshing artificial rains to the languishing fields. The procedure is, in brief, as follows: At some watering place, such as a river, brook, lake, or even a generous well, the water is pumped into a coarse-meshed network of pipes underlying the piece of land to be watered. From these fixed main pipe lines the water is led through flying pipes or movable conduits coupled to them at convenient points into flexible hose, which is coupled to peculiarly designed "rain wagons." These "rain wagons," made up into trains which may be as much as 200 meters long, are drawn about the fields as they pour out the needed "rain" in the desired amounts.

This device does not come from Utopia; it is actually in use in our dry eastern districts, where it has proved its value to large-scale agriculture over farms of about 2,000 hectares (5,942 acres). Four German factories are now putting out these installations, the only essential differences being in the execution, the design of the "rain wagons" and the manner of operation. The first installation for large-scale artificial raining was set up in 1910, and it was followed by fifteen to twenty additional outfits. It is really very strange that this field sprinkling has not been more extensively adopted, for the method has proved out splendidly and the drought of 1911 has emphasized the need for it. Perhaps it is because "artificial rain" sounds too Utopian, and also because of an exaggerated idea as to the first cost and the running expenses. It may be here stated that the first cost is not greater than that of other usual improvements, such as drains, etc., while the total current expense (including interest, deterioration, maintenance, and actual operation) is quite offset by the increased yield obtained even in the less dry years. In the dry years, on the other hand, artificial sprinkling so increased the net gains that the cost of installation may be wiped out the first year. Thus for the potatoes on the experimental field at Bromberg (a crop very responsive to watering), the watered plot in 1911 gave a net increased yield of 664 M.† per hectare (i. e., about 12,430 bushels net increase) as compared with the unwatered plot. Although such an increase in yield is not to be expected in large-scale farming, nevertheless the satisfaction expressed by those planters who own such an artificial sprinkling plant proves that there also the improvement is a paying one. Unfortunately space forbids presenting a detailed numerical demonstration of the magnitude of the net yields obtained by this means.

Whoever is interested in the details of this new improvement should procure and read the recently published Heft 276 of the "Arbeiten der Deutschen Landwirtschafts-Gesellschaft." The arrangement and operation of the present four types of "rain wagons" are there explained and discussed in detail. It is to be expected that the drought of 1915 will teach a lesson and direct the attention of the agriculturist more forcibly than usual to this new form of improvement. After its past successes, there can be no doubt as to its great agricultural significance.

* From *Berliner Lokal Anzeiger*, Saturday, June 26th, 1915.

† "M." i.e., malter; 12 Scheffer, or 18.72 bushels, if this is a Prussian measure.—*Cafr.*

Chinese Methods of Operating Machinery

According to the *Engineer* the acting British consul at Wuhu, reporting on the foreign machinery used in that city, remarks that the Chinese seem to expect that their machinery will run at full load during an indefinite number of years without other care than an occasional oiling, and that the economy of a maintenance and refit charge does not apparently appeal to the Chinese mind. The policy of getting quick and large returns without making allowances for the inevitably following exhaustion is unfair to the manufacturers, for machinery is unjustly blamed when the fault really resides in the Chinese lack of business method. He therefore suggests that it would pay manufacturers to allow long credits with a proviso that the supplier of the machinery should have the right to send a competent engineer to inspect it every two or three years. The purchaser would have to pay for the services of the expert, but that could be arranged for in the contract price.

Electric Activity in Ore Deposits—I*

Complicated Conditions and Some of the Results

By Roger C. Wells

As long ago as 1830 R. W. Fox called attention to electric activity in ore deposits.[1] Such currents as he was able to detect seemed to have no relation to the points of the compass, but appeared to be due to connections existing between different bodies of ore, or between different parts of the same body. In one mine the ore appeared to be increasingly negative with depth, a fact which he suggested might be dependent on temperature. His original paper contained a table showing the order of the electric conductivity of about twenty minerals and mineral combinations. In a later paper,[2] he took pains to show that certain ores may act like metals in galvanic combinations, and his principal conclusions are summed up in the statement that the electric phenomena in veins "bear a striking resemblance to galvanic combinations."

The subject was considered from a somewhat different point of view in 1870 by W. Skey[3]. Whereas the preceding investigators had sought for currents over large areas, Skey confined his observations to laboratory experiments on single minerals. He enlarged the known list of conducting minerals and determined the direction of the current when conducting minerals in contact with solutions are connected by a wire. Besides pointing out anew that conducting minerals are capable of forming the electrodes of galvanic batteries he called attention to the accelerating or retarding action of one mineral on another in chemical changes—action due to electric activity.

In 1880, at the instance of G. F. Becker, Carl Barus[4] investigated the electric activity of the Comstock lode and of the ore deposits at Eureka, Nev. Although he followed the experimental methods of Fox, Barus appears to have purposely avoided contact with metalliferous minerals. He concluded, from the measurements made at the Comstock lode[5] "that the electromotive forces due purely to chemical difference and polarization of the terminals are of the same order as the data expressing the electric activity of the lode." At Eureka the potentials of 21 points were measured against a single point of reference with terminals particularly designed to make a good contact with the solutions in the rocks. The maximum potential above the point of reference was 0.018 volt and the maximum below 0.093 volt. In the words of Barus:[6] "On reviewing the results described it is strikingly evident that the electromotive forces met with are invariably small, very frequently, indeed, quite at the limit of the accurately measurable." Electric prospecting, therefore, appeared to Barus impracticable.[7]

Experiments along the line indicated by Barus were made in 1897 by Bernfeld,[8] who studied the electric behavior of galena particularly, and more recently by Gottschalk and Buehler, who had previously shown that the oxidation and solution of certain natural sulphides are accelerated under certain conditions by the presence of pyrite or marcasite.[9] In explanation of this action, E. T. Allen[10] and I[11] separately ventured to express the opinion that it might be due to the production of sulphuric acid by the pyrite and marcasite. Soon afterward, in another paper, Gottschalk and Buehler pointed out once more that there may be electric action between different sulphides in contact; further, that marcasite and pyrite, which are electrically positive to stibnite and sphalerite when in moist contact with them, are in fact themselves somewhat protected from oxidation by the complementary action of the more oxidizable sulphides. They accordingly ascribed the chemical effects observed by them partly to electric action, and presented a list of conducting minerals and a table giving the electromotive forces shown by several minerals with respect to copper, water serving as electrolyte.

* An Abstract from *Bulletin 548, of the U. S. Geological Survey.*

1 Fox, R. W., On the electromagnetic properties of metalliferous veins in the mines of Cornwall: Philos. Trans., 1830, pt. 2, p. 399.

2 Fox, R. W., Note on the electric relations of certain metals and metalliferous minerals: Philos. Trans., 1835, pt. 1, p. 39.

3 Skey, W., On the electromotive power of metallic sulphides: New Zealand Inst. Trans. and Proc., vol, 3, pp. 232 to 236 (1871).

4 Becker, G. F., Geology of the Comstock lode and the Washoe district: U. S. Geological Survey Mon. 3, pp. 309 to 367 (chap. 10, On the electrical activity of ore bodies, by Carl Barus), 1882.

5 Idem, p. 322.

6 Idem, p. 365.

7 Idem, p. 366.

8 Bernfeld, I., Studien uber Schwefelmetallelektroden: Zeitschr. physikal. Chemie, vol. 25, p. 46, 1898.

9 Buehler, H. A., and Gottschalk, V. H., Oxidation of sulphides: Econ. Geology, vol. 5, p. 28, 1910.

10 Econ. Geology, vol. 5, p. 387, 1910.

11 Idem, p. 480.

This explanation of the alteration of ores by electrolysis is similar to the electrolytic theory of the corrosion of iron and steel and of the zinc of zinc plate. In view of the importance of the subject it has seemed desirable to extend the data, not only to correlate field results with laboratory experiments, but also to elucidate the effect of various solutions on the potentials and to harmonize the whole subject with modern theories, such as those of electricity and solution.

EFFECT OF VARIOUS SOLUTIONS ON THE POTENTIALS SHOWN BY MINERALS.

The potentials of different minerals as presented by Gottschalk and Buehler were determined by using water as the electrolyte and metallic copper as the second electrode.[12] Their opinion was that the electrolytic action of the sulphides "would be analogous in every respect to the action of metals." But, although it is well known that the potential shown by a metal as electrode depends on the concentration of the metallic ion in the solution in contact with it, Gottschalk and Buehler presented no data on the effect of variation in the solution. This was, therefore, the first subject to be investigated. A few measurements soon showed that not only do different minerals employed as electrodes exhibit different potentials in a given solution but also that the potentials shown by most minerals, certainly initial values, depend to a marked degree on the nature of the solutions in contact with the minerals. The variation shown by a mineral in passing from an acid to an alkaline solution is, in fact, generally greater than the differences shown by diverse minerals in the same solution. The potentials also depend on the oxidizing or reducing nature of the solutions. In general, acid and oxidizing solutions give the highest potentials, alkaline and reducing solutions the lowest.

A most significant fact for the elucidation of these phenomena is that any unattackable electrode, such as a piece of smooth platinum, shows somewhat similar behavior in the various solutions. The table below gives a few single potential measurements which illustrate this point. The solutions were approximately normal and the sign is that assumed by the electrode with reference to the normal calomel electrode as +0.560 volt, the measurements being made soon after the specimens were placed in the solutions. Of course, neither equilibrium nor constancy was wholly obtained under these circumstances in the time allowed.

EFFECT OF VARIOUS SOLUTIONS ON THE POTENTIAL, IN VOLTS.

	Pyrite.	Galena.	Magnetite.	Pyrrhotite.	Platinum.
Acidified ferric sulphate	+1.10	+0.80	+0.91	+0.97	+1.11
Sulphuric acid........	+0.86	a +0.49	+0.88	+0.89	+0.97
Potassium chloride....	+0.72	+0.49	+0.68	+0.56	+0.76
Sodium hydroxide....	+0.38	a +0.16	+0.53	a +0.13	+0.38
Sodium sulphide......	−0.17	−0.22	−0.14	a −0.14	−0.26

a Mineral appreciably attacked yielding an indefinite value

On considering these results a number of important questions at once arise. Is it possible to frame a consistent explanation of all the values? How constant and reproducible are they? Which of them, if any, are capable of furnishing noteworthy currents for electrolytic action? Is such action possible in ore deposits? If so, what are the effects of electrolytic action on various minerals?

It may be said at once that most of these potentials are reproducible to tenths of a volt and some to hundredths. Our knowledge of the behavior of various electrodes would lead us to expect, however, that the products formed by solution of the minerals would have an effect on the potentials. To yield significant potentials the solutions should contain definite concentrations of the possible reacting substances, but as the concentrations could not be regulated by the method of experimentation used above the values are simply illustrative and have no exact quantitative significance.

The measurements are suggestive, however, because they represent temporary stages in slow chemical adjustments. Some of these adjustments occur very slowly, so slowly that fairly constant potentials are soon obtained; others occur more rapidly and the reaction products cause a changing potential. Measurements of electromotive force may be used to indicate the direction and intensity of a given chemical action and generally furnish such indications with as great accuracy as chemical experimentation. Moreover, such measurements may be made quickly.

12 Gottschalk, V. H., and Buehler, H. A., Econ. Geology, vol. 7, p. 31, 1912.

The potential shown by the minerals and the platinum as indicated in the preceding table evidently have something in common and are affected in a similar way by the solutions. The variations shown seem to be characteristic of the potentials ordinarily termed "oxidation and reduction" potentials. When the electrode appears positive the usual assumption is that positive electricity has passed from some ion in the solution to the conductor (platinum ordinarily), or, what amounts to the same thing, that negative electricity has passed from the electrode to the solution. The ferric ions present in a ferric salt solution, for example, are capable of acting as oxidizers—that is, of parting with a portion of their electrification and thereby becoming converted into ferrous ions. The electric potential measures the tendency of this chemical process to occur. Evidently this general effect is shown even with the mineral electrodes in the above measurements, but with the minerals there is the added possibility that their constituents may ionize and carry electric charges with them into the solution as they dissolve. Considering the similar effects shown by the minerals and by platinum, however, it must be said that the potentials indicate in a general way the order of the oxidizing power of the solutions.

There can be no question that the potentials shown by unattackable electrodes are related to the oxidizing or reducing nature of the solutions in contact with them, and further, that a number of the common metalliferous minerals exhibit initial potential values which may obviously be referred to the same cause.

These facts may possibly help us to explain in part the electromotive forces noted in the earth by Fox. The solutions in the upper levels of ore deposits are likely to be oxidizing and acid, but with increase in depth they become more reducing and less acid. For these reasons isolated portions of ore in the upper levels may possess a higher electric potential than portions in the lower levels, and such detectable electric currents as might be caused by this difference would be more likely to take a vertical than a horizontal direction. Of course, variations in the nature of the solutions might also give rise to differences in potential in horizontal directions. However, the presence of dissimilar solutions in contact with ores suggests a very probable cause of differences of potential in the earth.

It appeared to be a matter of practical importance to determine whether the above potentials could yield currents available for producing appreciable chemical action, or whether such electrodes are very easily polarizable. This question was accordingly put to an experimental test.

There seems to be no question about the competency of an oxidizing solution like acidified ferric sulphate to furnish a noteworthy current when a platinum electrode is employed as a cathode, and conjoined with any unpolarizable anode. In oder to compare this action with that occurring when electrodes of pyrite are involved the following experiments were performed: In one beaker was placed an acidified solution of ferric sulphate, in another beaker a solution of sodium sulphide, both solutions being approximately normal. The platinum electrodes measured 2 by 2 centimeters. The beakers were connected by a wick saturated with normal sodium sulphate. The potential of this combination on open circuit, calculated by the data in the preceding table is 0.93 volt. The external circuit was completed by a voltmeter and sufficient additional resistance was introduced to bring the total resistance of the circuit, including the resistance of the liquid (all resistances being actually determined), up to 3,000 ohms, which is comparable to the resistance of some geologic strata. On closing the circuit the electromotive forces and currents tabulated below were noted, the electromotive force stated being equivalent to the fall in potential over the whole circuit.

OXIDATION AND REDUCTION CURRENT WITH PLATINUM ELECTRODES.

Time.	Effective Electromotive Force.	Current.
	Volt.	*Milliampere.*
0.1 minute........	0.96	0.31
1.0 minute........	0.94	0.30
5.0 minutes........	0.94	0.30
10.0 minutes........	0.88	0.29
16.0 hours........	0.76	0.25

The current was found to vary, of course, with the resistance of the circuit. As it continued to flow reduc-

tion ensued at the cathode and oxidation at the anode, thereby equalizing the differences and slowly lowering the potential and current. It was not thought necessary to extend the readings further, as the availability of the combination to furnish a noteworthy current was shown. Electrodes of pyrite were then substituted for the platinum. The external resistances were lowered to bring down the total again to 3,000 ohms, when the following results were noted:

OXIDATION AND REDUCTION CURRENT WITH ELECTRODES OF PYRITE.

Time.	Effective Electromotive Force.	Current.
	Volts.	*Milliampere.*
0.1 minute	1.04	0.34
1.0 minute	1.02	0.33
5.0 minutes	1.00	0.33
10.0 minutes	1.00	0.33

It is evident from these results that chemical differences between solutions are capable of producing appreciable currents for some time whether the electrodes are of platinum or of a conducting mineral. The polarization appeared to be a little greater, in fact, with the platinum than with the pyrite. The important point for geologic application is that the chemical differences may be equalized at considerable distances as well as locally by electrolytic action when the proper circuits are present.

ELECTRIC CURRENTS IN THE EARTH.

In the earth the two electrodes and wire might have their counterpart in a single portion of ore or several ores in contact. The liquid connection might consist of moist rocks or vein solutions. Many possible combinations in the earth's crust might produce electric action. By a judicious use of the imagination it is possible to perceive that this action might affect either fairly large zones or, on the other hand, might contribute to the development and alteration of the most minute particles in tiny veinlets.

It may be stated that there are good reasons to believe that all minerals are attacked by all solutions, but in widely varying degrees. For example, even pyrite, one of the least attackable sulphides, is affected slowly by acidified ferric sulphate. The action results in the production of ferrous salt in the solution, which may proceed both from the reduction of the ferric salt and from the solution of a part of the iron of the pyrite. Experiments have shown that a dilute acid mixture of ferric sulphate and potassium ferricyanide causes the development of an adherent blue precipitate on pyrite, as well as on marcasite, chalcopyrite, and pyrrhotite. That this precipitate adheres in a very thin film seems to be evidence that the minerals function in the reaction.

As pyrite, therefore, is capable of slowly reducing ferric sulphate, it is obvious that any electric action which could arise from the oxidizing power of ferric sulphate would occur chiefly on account of the fact that pyrite enters into direct action very sluggishly—that is, the electric reduction of the ferric solution may occur far more readily under some circumstances than direct reduction by the pyrite. With the more attackable minerals the possibility of electric action would be less than with pyrite, but sufficient evidence has been presented to show that appreciable currents may be developed by various combinations of solutions and minerals. There is always the possibility that electric action may be a more ready way of equalizing chemical differences than direct action. This possibility is in accord with the statement of Becker that it appears to be a law of nature for available energy to be expended as rapidly as possible. Accordingly, chemical energy should be converted into electric energy whenever the attainment of equilibrium would be thereby hastened. Becker has called this a principle of maximum dissipativity.[13]

In addition to the ever-present chemical sources of electric currents in the earth, mention may be made of the fact that sulphides are capable of developing thermo-electromotive forces, a subject which has been investigated by A. Abt,[14] who gives the following thermoelectric series:

Abt's Thermoelectric Series.

1. Chalcopyrite.
2. Pyrolusite.
3. Bismuth.
4. Zinc.
5. Nickel.
6. Copper.
7. Cadmium.
8. Nickel ore.
9. Arc-light carbon.
10. Iron.
11. Pyrrhotite.
12. Antimony.
13. Pyrite.

Diffusion is also capable of developing electric currents and is the cause of potentials between different solutions. These facts are sufficient to justify a study of the behavior of minerals under electric influences.

The fact that appreciable earth currents have seldom been found at any given point does not exclude the possibility that local electric action may be a potent agency in hastening chemical adjustments, or that very small currents acting for long periods would be capable of accomplishing great results. Of course, present conditions in the earth are the result of adjustments and re-adjustments which have been going on for ages. The same forces are available now as always, but ore deposits may represent the result ot very long accumulation. It would be incorrect to say that the electric batteries have run down, but, on the other hand, we can hardly expect to find batteries in the field comparable in intensity with those which we can construct in the laboratory. The laboratory results enable us to detect the tendencies at work. Where the action is distributed over a vast distance it appears that even the best experimentation might be unable to detect the action going on.

It will be desirable to discuss separately the several parts of such circuits as those suggested, consisting of various solutions and minerals. The part requiring the least attention for the present purpose is the liquid connection, for it is well known that solutions of inorganic substances, although varying in conductivity with their nature, concentration, and temperature, are on the whole good conductors of electricity.[15] One important point, however, must be emphasized. A current in a solution is due to the actual movement of ions through the solution, a subject thoroughly studied by Hittorf as long ago as 1850. The positively charged cations move in one direction, the direction usually called the "current," the negatively charged anions in the opposite direction. It follows from this that wherever electric currents flow in liquid circuits the cations migrate in one direction, the anions in another. For example, an electric current passing up a vein solution would actually consist in the transport of cations upward and of anions downward in the vein solution. Either migration or interchange of ions would also necessarily occur in "local action."

EFFECT OF A CURRENT FROM SOLUTION TO MINERAL.

A current flowing from a solution to an electrode makes a cathode combination, and according to the well-known principles of electro-chemistry, must be accompanied by "reduction." The chief question that arises is whether the reduction affects the constituents of the solution or the mineral forming the electrode. Experiments to determine this point were made in two ways: First, fairly large currents—several hundredths of an ampere—were applied from an outside source; second, more feeble currents were employed—a few milliamperes.

Effects at the Cathode With Moderate Currents.—Ferric sulphate solution in contact with pyrite was reduced. In dilute sulphuric acid hydrogen and a trace of hydrogen sulphide were evolved. The smooth crystal faces of the pyrite appeared to be irregularly corroded, minute cavities being distributed over their surfaces. Iron was electroplated upon pyrite from a solution of ferrous sulphate, copper from cupric sulphate, silver from silver sulphate, gold from a solution of chlorauric acid, and platinum from a solution of chlorplatinic acid. A piece of pyrite weighing 35 grams was made cathode for five hours in a weak solution of sodium carbonate with a current of 0.04 ampere. The specimen remained bright and lost only 0.0025 gram. Hydrogen was evolved. From caustic soda or sodium sulphide solutions hydrogen was also evolved, but very little or none was evolved from a solution of sodium polysulphide, which suggests that the polysulphide was reduced by the current. With neutral salt solutions, such as those of sodium chloride or sodium sulphate, the solution on electrolysis became alkaline around the cathode.

Marcasite and pyrrhotite behaved much like pyrite as cathodes but were not studied in detail. Galena in sodium sulphate solution suffered some mechanical disintegration along clevage planes, a fact which suggests that the electric polarization may extend into the minutest capillary spaces. As a result of the action sodium sulphide was formed in the solution. The electrolysis of cathodes of galena in normal sodium hydroxide was stated by Bernfeld to yield one equivalent of metallic lead for each equivalent of sulphur set free or passing into solution.[16]

Magnetite was reduced very slowly if at all in the solutions tried.

Pyrolusite is known to be readily reduced when acting as cathode, its use as depolarizer in the Leclanche cell depending on this fact.

Effects at the Cathode With Feeble Currents.—Ferric sulphate in contact with pyrite was reduced. Gold, platinum, silver, and mercury were precipitated from their soluble salts in metallic form on pyrite. The products resulting from sulphuric acid with pyrite, as far as they could be identified, were hydrogen, some hydrogen sulphide, and ferrous sulphate. The pyrite appeared to remain bright and untarnished, however. With sodium chloride and pyrite hydrogen was evolved and the solution became alkaline and showed a trace of soluble sulphide. When cupric sulphate was electrolyzed, if the solution was neutral, some copper was deposited; but under the microscope the copper was seen to shade off into a dark-colored deposit of microscopic cubic crystals which were too small to be identified with certainty. A white precipitate, presumably basic sulphate, was also formed in the solution. No evolution of gas occurred. In a solution that was weakly acid and free from chlorides copper was the first visible product observable on the pyrite. In the presence of chlorides, however, a film consisting of microscopic tetrahedra appeared on the surface of the pyrite, and this film proved to be cuprous chloride.

The time at my disposal has not been sufficient to enable me to make some other experiments of this kind, especially with feeble currents, and the effects obtained might, in some experiments, differ from the effects produced by larger currents on account of the slow rate at which the very insoluble minerals react with cold solutions. The experiments made indicate that the changes consist principally in a reduction of the constituents of solutions in contact with pyrite. Other possible effects are the deposition of free metals, the formation of hydrogen sulphide, the development of alkalinity, or the evolution of hydrogen or hydrogen sulphide. The sulphides at least are much more resistant as cathodes than as anodes, as will be next shown.

EFFECT OF A CURRENT FROM MINERAL TO SOLUTION.

When sulphides function as anodes they are attacked much more vigorously than when they function as cathodes. Thus, pyrite lost fifty times as much in weight with the same current when anode as when cathode in dilute sodium carbonate solution, and seven times as much in dilute nitric-acid solution. Pyrrhotite lost seven times as much when anode in sodium sulphide solution as when cathode.

The loss of weight of a pyrite anode in a solution of sodium carbonate, in spite of the fact that it became coated with ferric hydroxide, must have been due to oxidation and solution of the sulphur, which was converted, in part at least, into sulphate, thus showing that both constituents of the pyrite were oxidized. Anodes of pyrite in a solution of sodium sulphide were immediately blackened by ferrous sulphide, which was formed as soon as current was applied. A pyrite anode in a solution of copper sulphate became coated with black iridescent copper sulphide. Under similar conditions, with a solution of ferrous sulphate, the anode suffered very little change in weight and extremely slight discoloration, the chief effect of the current consisting in the oxidation of the ferrous sulphate. As compared with its behavior in a solution of sodium sulphide or any other metallic salt the behavior of pyrite in a solution of ferrous sulphate suggests a sort of simultaneous decomposition and regeneration of the pyrite, the net result being hardly noticeable.

In acid solutions no oxygen was evolved on anodes of pyrite with currents of slight intensity. Instead, iron passed into solution as ferric salt. Part of the sulphur was oxidized to sulphate; the rest remained on the anode in the free state. The electrode was noticeably tarnished by films of various shades—gray, purple, and black— the color changing in the order indicated as the experiment was continued.

In some of these experiments higher potentials were applied than those produced by natural combinations, and the results must be judged accordingly and taken as suggestions of the tendencies at cathode and anode, respectively. Further study along this line should be made by those who are interested in special problems likely to be related to the phenomena.

ELECTRIC CONDUCTIVITY OF MINERALS.

Another part of the suggested circuit is formed by the mineral conductors. Fox determined that pyrite, arsenical pyrite, galena, pyrolusite, and tetrahedrite are conductors of electricity; that molybdenite is a very imperfect conductor; and that argentite, cinnabar, stibnite, bismuthinite, realgar, and blende are non-conductors. Later observers added other minerals to these categories from time to time.

The theory of electrostatic separation is that fine particles of most substances are attracted toward an electrically charged body, but that only those that are conductive will acquire the same charge and be repelled. If this theory is correct it should be possible to set down a list of the conductive minerals by observing their electrostatic behavior.

It was pointed out by Braun[17] that the conductivity of some minerals is a function of the direction and time

[13] Becker, G. F., A new law of thermochemistry: *American Journal Science*, 3rd ser., vol. 31, p. 120, 1886.

[14] Abt, A., Thermoelectromotive force of some metal oxides and metal sulphides in combination with one another and with simple metals with 100 degrees difference of temperature of the contact points: Annalen der Physik, 4th ser., vol. 2, p. 266, 1900.

[15] On the conductivity of mine walls and veins see Barus, Carl, U. S. Geological Survey Mon. 3, p. 345, 1882. The resistances noted were of the order of thousands of ohms.

[16] Bernfeld, I., Studien uber Schwefelmetallelektroden: Zeitschr. physikal. Chemie, vol. 25, p. 53, 1898.

[17] Braun, F., Ueber die Stromleitung durch Schwefelmetalle: Poggendorff's Annalen, vol. 153, p. 556, 1874.

of passage of the current. Dufet[18] took exception to these conclusions, which were supported later, however, by the work of Bernfeld[19] on galena.

The conductivity of some sulphides increases with a rise of temperature, as in electrolytic conductors, the behavior of silver sulphide in this respect having been noted by Faraday.[20] The suggestion has been made that the passage of a current in these sulphides causes them to decompose into their elements, but no such decomposition could be observed by Bernfeld with galena. In some experiments heretofore made the contacts used in mounting sulphides for tests have been the chief source of irregularities in their conductivity.[21] At high temperatures even silicates possess appreciable electric conductivity. It thus appears that a very large number of minerals are susceptible to electric influences.

(*To be continued.*)

Correspondence

[*The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.*]

The Value of Snakes

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

It was most gratifying to note, in your issue of December 18th, the very substantial and excellent support which Mr. W. H. McClellan, of Woodstock College, gives my plea to save and encourage the useful and harmless snakes of this country, and my effort to point out to our agriculturists the valuable service these reptiles render annually in the matter of destruction of such vermin as feed upon or otherwise destroy the products of the farm and garden.

Your correspondent's comments upon my article are of distinct value, in that they emphasize the importance of considering questions of this character; and while I may have—and probably did—somewhat overestimated the number of field mice that our innocuous snakes annually destroy, I am very pleased to note that such an observer as Mr. McClellan appears to be can, in the main, agree with me to the extent that he has in his letter to the SUPPLEMENT of the above date. He, in his estimate—which I must believe is an extremely conservative one—claims that 500 of those harmless snakes known as "racers" will, in a single season, consume no fewer than 6,000 field mice. Well and good. I will admit that; and it is a pretty good record, especially as it certainly must be not a little below the average. I say this for the reason that Mr. McClellan bases his estimate upon specimens of those snakes kept for different lengths of time in *confinement;* it is no more than fair to presume that their appetites would be much better were they at large and living normal lives in a state of nature.

However, 6,000 field mice are a good many field mice; it may mean 3,000 breeding pairs. If each pair rears only three young to the litter, it means 9,000 field mice, and if they litter twice in the season, it may mean 18,000 field mice; the amount of harm that this little army of rodents can do the grain-raiser I am quite content to leave to such a careful computer as your correspondent has proved himself to be. Moreover, I may say in passing that this in no way touches on the thousands upon thousands of noxious insects our harmless snakes annually destroy.

Mr. McClellan holds that I am in error in asserting that the *garter snake* eats young field mice. To this I can only reply that so well known a fact must have slipped his observation up to the present time. It is best proven by capturing such garter snakes as one can during the summer months, in and around country barns, in those districts where that species ranges, and examine the contents of their stomachs. In the fifth volume of "The Animal World" (p. 314) Wood, who is a pretty good naturalist, says, after pointing out that most of our snakes spend their time mainly hunting for frogs, toads, tadpoles, mice, insects, etc., upon which they feed, that "Among these probably the most often seen are the striped garter snakes which abound in meadows and about haystacks and old barns, where they search holes and corners for mice and beetles." This statement occurs in other works in our zoölogical literature, both popular and scientific.

But, apart from this, let the agriculturist ponder well upon the truth of the above statement, especially in regard to the *number* of *garter snakes;* that they live in the *meadows* and around *old barns* and *haystacks,* where they *search* for *mice, etc.* That is a good record for garter snakes, and farmer boys should be instructed to cease killing them by the score every summer, thus giving the mice a chance.

If I have not already made too great a demand upon your generosity in the matter of consumed space, I would like to quote a paragraph from Cope's magnificent work, "The Crocodilians, Lizards, and Snakes of North America," published by the Smithsonian Institution. The late E. D. Cope was the greatest herpetologist that this country has ever known, and on page 714 of the work cited he says: "Snakes are for the most part carnivorous; a few forms, as, for example, the genus *Herpeton,* are more or less herbivorous. They are most effective restrainers of the undue increase of the small Mammalia, and, in the case of the smaller snakes, of the increase of insects, by the destruction of the larvæ, as well as of the imagines. They are the assured friends of the agriculturist, and as such should be permitted to live and increase. This may be safely done in North America, where there is really but one species of venomous snakes not easily distinguished, the *Elaps fulvius,* and that is confined to the Gulf border and a small part of that of the southern Atlantic. Some of the large Colubrine snakes, for example, of the genus *Compsosoma,* are permitted to live in and about the houses of the natives in some parts of South America, and in some localities of western North America the large and harmless Pityophides perform the same function. All of our species of Colubroidea, however, are of utility to man and should be permitted to live, not only on this account, but also on account of the beauty of their forms and often coloration."

This could well be the last word on the value of snakes to our agriculturists; the Federal Government should take a hand and inaugurate legal measures to protect and propagate our useful and innocuous snakes.

Washington, D. C. R. W. SHUFELDT, M.D.

[18] Dufet, H., Sur la conductibilite electrique de la pyrite: Compt. Rend., vol. 81, p. 628, 1875.

[19] Bernfeld, I., Studien uber Schwefelmetallelektroden: Zeitschr. physikal. Chemie, vol. 25, p. 50, 1898.

[20] Poggendorff's Annalen, vol. 31, p. 242. 1834.

[21] Hayes, H. V., Note on the electrical conductivity of argentic sulphide: Am. Acad. Arts and Sci. Proc., vol. 46, p. 613, 1910.

Potash in Spain

FOR some time past potash deposits have been known to exist near Barcelona, and borings and analyses have been repeatedly made in the region where the salts are found in the provinces of Barcelona and Lerida. According to a report by the United States Consul-General at Barcelona, the results have been particularly favorable, but it will require the employment of capital and enterprise to make potash in this region a commercially profitable product.

In the various borings near the town of Sarria, potash salts were found at depths between 121.33 and 196.85 feet and others at 426.50 feet. At 885.82 feet, the greatest depth attained, important quantities of potassium compounds were found to rest on a stratum of white salt not yet pierced. In the area tested by borings comprising some 2,690,000 square feet there are approximately 2,550,000 tons of carnallite and 1,150,000 tons of sylvite, which should produce a total of 3,675,000 tons of potassium salts.

From the general characteristics of the region it is considered probable that there are further deposits in greater or less proximity to those already tested. In a stream running by the salt works of Cardona there is a large percentage of potash in solution, and it has been discovered that vast quantities of potash have already been allowed to go to waste in the salt mines that might have been profitably used.

On account of the exceptionally irregular geological formation of this particular part of the country near Barcelona it is difficult to make exact valuations of the amount of potash salt that can be mined. Nevertheless, the presence of certain gypsum beds and the potash holding streams will serve as a guide to determine the continuation of the potash deposits.

Particular interest has been displayed in these potash deposits by non-Spanish capitalists. One large tract is already owned outside of Spain, but in view of the great national importance of the deposits the Spanish Government are taking measures for their supervision, if not for their exploitation.

At the present time the amount of potash used per square mile of cultivated land in Spain is very small compared with that used in some countries. Nevertheless, fairly large imports of potash have been made in Spain, and it would be greatly to the advantage of Spanish agriculturists to use the domestic product, which it is calculated could be sold at about £10 a ton, or £5 a ton less than the cost of the imported product of the best grade. Since the beginning of the war, imports of potash have practically ceased. When the product now latent near Barcelona is brought to the surface and made a marketable commodity, there should ultimately be a surplus for export after the home requirements are satisfied. For the time being, however, in spite of a great outside demand, there can be no export of potash mined in the country.—*Journal of the Royal Soc. of Arts.*

Management of the Power House

A WRITER in the *General Electric Review* in speaking of the advantages of isolated power plants for factories makes the following pertinent remarks in regard to the management of such a plant.

A power house must be operated on a methodical and intelligent basis if it is to be run economically. At its head must be a man who not only knows his work, but who also has at heart the interest of the company. Too often the men in charge of power houses are subject to the whims and caprices of superiors in rank who have not the slightest idea of the rudiments of engineering.

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